



Digitized by the Internet Archive
in 2024



AS
36
R332
n/c

Volume I: 1946-1962

Index of Selected Publications of
THE RAND CORPORATION

August 1962

The RAND Corporation

"... a nonprofit corporation... formed... to further and promote scientific, educational, and charitable purposes all for the public welfare and security of the United States of America."

—ARTICLES OF INCORPORATION

PREFACE

The RAND Corporation, established in 1948 as an independent, nonprofit organization, is engaged in a program of research concerned with the security and public welfare of the United States. This research is financed by the United States Air Force, by other government agencies, and by the Corporation.

In keeping with the established Air Force policy of disseminating the unclassified results of research, RAND has made unclassified publications available to government agencies, to individuals engaged in research at universities and institutes, and to industrial organizations concerned with scientific research and development.

Organization of the Index and Description of Its Contents

The RAND *Index of Selected Publications* comprises three parts: Part I lists the publications according to subject category. Part II contains a numerical listing and abstracts of unclassified Reports, RAND Memoranda, Papers, and Translations published by The RAND Corporation. Part III lists the publications by author.

All RAND publications, both classified and unclassified, are numbered in sequence within each series: *Reports* (R's) typically describe major research studies or extensive investigations. *RAND Memoranda* (RM's) are primarily working papers reporting on the progress of research or one phase of an investigation (RAND Memoranda may be expanded, modified, withdrawn, or published in another form at a later date). *Papers* (P's) are individual productions of the author, usually prepared for publication in journals or for presentation at meetings. *Translations* (T's) are articles translated by RAND from foreign-language publications. With the release of Translation T-146, this category of RAND publication was discontinued and is now incorporated in the RAND Memoranda series. Since only unclassified publications are listed in this Index, the numbers in each series will not be consecutive.

The present volume of the Index, includes selected publications for the years 1946-1962. Supplemental pages listing new items are distributed bimonthly and are collected and published annually.

How RAND Publications Can Be Obtained

RAND believes that it is in the public interest, and in the interest of scientific progress, to make unclassified publications widely available to individuals everywhere. Since it is not possible to give copies to all who wish to use them, or to set up facilities to sell such publications, the Air Force has authorized a system of repositories in libraries across the country, and The RAND Corporation has donated deposits to libraries in several foreign countries. (A list of these deposit libraries is given on pages vii through xi.) RAND publications in deposit libraries are available to patrons on the same basis as other publications in the libraries and are subject to the same rules and regulations; they can be obtained by patrons of other libraries through the Interlibrary Loan Service.

In Parts I and II of this Index, *publications that are available in deposit libraries are identified by the symbol ●; those that are not on deposit in foreign libraries are identified by the additional symbol △. In Part II, publications that have been deposited with the Office of Technical Services (OTS) are identified by the symbol ∅.* The Office of Technical Services is a government agency that reproduces and distributes material published by other government agencies and private organizations. RAND publications can be obtained from OTS at a nominal cost covering reproduction and handling. Requests for publications should state the number, title, and author of each publication and should be addressed to

Technical Information Division
Office of Technical Services
U.S. Department of Commerce
Washington 25, D.C.

When RAND Papers listed in this Index have been published in professional journals, the place and date of publication are given in the abstracts.

Out-of-Print Publications

Publications listed as being "out of print" are not available unless they have been placed in deposit libraries (indicated by the symbol ●) or have been published by commercial publishers (indicated by an asterisk after the words "out of print," in which case they are available from the commercial publishers named in the abstracts).

Publications Listed as Not Available

Some of the publications are listed as "not available" because they are not deposit items and certain restrictions preclude their distribution to requesters.

Suffixes

Four publication-number suffixes are used in this Index. They identify the agency sponsoring the research: AEC (Atomic Energy Commission), FF (Ford Foundation), PR (U.S. Air Force Project RAND), RC (The RAND Corporation). Papers, unless Corporation-sponsored, do not bear suffixes. With this exception, all publications issued prior to October 1961 that are not identified by a suffix are understood to have been sponsored by Project RAND.

CONTENTS

PREFACE	iii
DEPOSIT LIBRARIES IN THE UNITED STATES	vii
DEPOSIT LIBRARIES ABROAD	xi
PART I	
Subject Index: Table of Organization	1
Subject Index	5
PART II	
Reports	R-1
RAND Memoranda	RM-1
Papers	P-1
Translations	T-1
PART III	
Author Index	A-1

DEPOSIT LIBRARIES IN THE UNITED STATES

A complete collection of the publications indicated in this Index as repository items has been deposited with each of the libraries listed below except as noted. (For further information, see the Preface, pages iii and iv.)

California

Berkeley: University of California at Berkeley
Los Angeles: University of California at Los Angeles
Pasadena: California Institute of Technology
Stanford: Stanford University

Colorado

Denver: Bibliographical Center for Research

Connecticut

New Haven: Yale University

Washington, D.C.

The Library of Congress

Florida

Gainesville: The University of Florida

Georgia

Atlanta: Georgia Institute of Technology

Hawaii

Honolulu: University of Hawaii (partial deposit, beginning with
R-287, RM-1606, and P-787)

Illinois

Chicago: The University of Chicago
Urbana: University of Illinois

Indiana

Lafayette: Purdue University

Iowa

Ames: Iowa State College of Agriculture and Mechanic Arts
Iowa City: State University of Iowa

Kentucky

Lexington: University of Kentucky

Maryland

Baltimore: The Johns Hopkins University

Massachusetts

Cambridge: Harvard University

Massachusetts Institute of Technology

Michigan

Ann Arbor: University of Michigan

Minnesota

Minneapolis: University of Minnesota

Missouri

Kansas City: Linda Hall Library

St. Louis: Washington University

Nebraska

Lincoln: The University of Nebraska

New Jersey

Princeton: Princeton University

New York

Ithaca: Cornell University

New York: Columbia University

The New York Public Library

North Carolina

Durham: Duke University

Ohio

Cleveland: Cleveland Public Library

Columbus: Ohio State University

Oklahoma

Norman: The University of Oklahoma

Oregon

Corvallis: Oregon State College

Pennsylvania

Pittsburgh: Carnegie Library of Pittsburgh

Rhode Island

Providence: Brown University

Tennessee

Nashville: Joint University Libraries

Texas

Austin: The University of Texas

Utah

Salt Lake City: University of Utah

Virginia

Charlottesville: University of Virginia

Washington

Seattle: University of Washington

Wisconsin

Madison: The University of Wisconsin

DEPOSIT LIBRARIES ABROAD

A complete collection of the publications indicated in this Index as repository items has been deposited with each of the libraries listed below except as noted. (For further information, see the Preface, pages iii and iv.)

Australia

Sydney: The University of Sydney (partial deposit beginning with R-287, RM-1606, and P-787)

Canada

Ottawa: National Research Council of Canada

England

London: Science Museum Library

France

Paris: Centre Français de Recherche Operationnelle

Germany

Frankfurt A.M.: Stadt- und Universitäts-Bibliothek

Japan

Tokyo: National Diet Library (complete deposit except for R-245)

Sweden

Stockholm: Handelshögskolans Bibliotek

PART I

SUBJECT INDEX: ORGANIZATION

Aerodynamics and Fluid Mechanics—See also Aircraft, Applied Mechanics, Defense Studies, Missiles, Nuclear Studies, Physics, and Space Flight	SI-7
Atmospheric Re-entry	SI-7
Boundary Layers	SI-7
Drag Estimation	SI-8
Heat Transfer	SI-8
Hypersonic Aerodynamics	SI-9
Magnetohydrodynamics	SI-10
Miscellaneous	SI-10
Stability and Control	SI-11
Supersonic Aerodynamics	SI-11
Aerophysiology—See Physiology	
Aircraft—See also Aerodynamics and Fluid Mechanics, Bombing, Logistics, Navigation, Offense Studies, Operations, Propulsion, Reconnaissance, Reliability, and Structures	SI-12
Bombers	SI-12
Capabilities and Performance	SI-12
Fighters and Interceptors	SI-13
Miscellaneous	SI-13
Range Extension	SI-14
Transports and Support Aircraft	SI-14
Applied Mechanics—See also Aerodynamics and Fluid Mechanics, and Space Flight	SI-15
Flight and Celestial Mechanics	SI-15
High-speed Impact	SI-15
Miscellaneous	SI-15
Wave Propagation	SI-16
Astrophysics—See Physics and Space Flight	
Bombing—See also Aircraft, Defense Studies, Missiles, Nuclear Studies, Offense Studies, Operations, Radar, and Targets	SI-16
Damage Analyses	SI-16
Miscellaneous	SI-17
Target Coverage Problems	SI-17
Central War—See Operations	
Communications—See also Electronics, and Social and Political Science	SI-18
Complex Information Processing	SI-19
Cost Analysis Studies—See also Economics and Logistics	SI-20
Budgeting	SI-20
Cost Methodology	SI-20
Miscellaneous	SI-21
Weapon System Cost Estimates	SI-22
Countermeasures and Counter-countermeasures—See also Defense Studies, Electronics, Infrared Studies, and Radar	SI-22
Defense Studies—See also Aircraft, Bombing, Countermeasures and Counter-countermeasures, Infrared Studies, Missiles, Offense Studies, Operations, Radar, and Targets	SI-22
Bases	SI-22
Civil Defense	SI-23
Detection	SI-23
Enemy Offensive Capabilities	SI-23
Interception and Interceptor Control	SI-23
Mathematical Models	SI-23
Miscellaneous	SI-24
Passive Defense	SI-24
Targets	SI-25

Economics—See also Cost Analysis Studies, Logistics, and Systems Analysis	SI-25
Economic Aspects of Military Planning	SI-25
Economic Models	SI-26
Economic Theory: Econometrics	SI-28
Economic Theory: General	SI-29
Economic War and Recuperation Potential	SI-31
Foreign Economics Studies (Excluding S.U.)	SI-32
Miscellaneous	SI-33
Process Analysis and Industry Studies	SI-33
Soviet Agriculture	SI-35
Soviet Industry and Transport	SI-35
Soviet National Income and Product	SI-36
Soviet Planning: General and Investment	SI-36
Soviet Population, Labor, and Trade	SI-37
Soviet Prices	SI-37
Targets	SI-38
Education—See also Complex Information Processing, Mathematics, and Psychology	SI-39
Electromagnetic Wave Propagation	SI-39
Electronic Environment Studies—See also Radar	SI-40
Electronics—See also Communications, Countermeasures and Counter-countermeasures, Guidance and Control, Infrared Studies, Navigation, Radar, Reconnaissance, and Reliability	SI-40
Fallout—See Meteorology	
Game Theory—See also Mathematics and Statistics	SI-41
Best Strategies	SI-41
Continuous Games	SI-41
Discrete Games	SI-42
Examples	SI-42
Games in Extensive Form	SI-43
Games of Timing	SI-43
Games over Function Space	SI-44
Gaming and Simulation	SI-44
General Theory	SI-45
Methods of Solving	SI-45
Models and Applications	SI-46
Non-zero-sum and <i>n</i> -Person Games	SI-47
Geophysics—See also Meteorology and Physics	SI-48
Guidance and Control—See also Electronics, Navigation, Radar, and Space Flight	SI-49
Human Engineering—See also Space Flight	SI-50
Infrared Studies—See also Countermeasures and Counter-countermeasures, Defense Studies, Electronics, and Radar	SI-51
Language—See also Mathematics	SI-51
Data Processing	SI-51
Machine Translation	SI-52
Limited War—See Operations	
Logistics—See also Aircraft, Cost Analysis Studies, Economics, Mathematics, and Operations	SI-52
Data Processing	SI-52
Logistics Systems Laboratory	SI-53
Maintenance	SI-54
Miscellaneous	SI-55
Missiles	SI-56
Supply	SI-56
Transportation and Mobility	SI-58
Mathematics—See also Game Theory, Language, Logistics, and Statistics	SI-58
Adaptive Processes	SI-58
Biological and Medical Studies	SI-59
Classical Analysis	SI-59
Computing Machines	SI-60

Control Processes	SI-63
Differential Equations	SI-63
Dynamic Programming	SI-65
Extremum Problems	SI-70
Functional Representation	SI-71
Inequalities	SI-71
Integral Equations	SI-72
Learning Theory	SI-72
Linear Programming	SI-72
Linear Spaces	SI-76
Miscellaneous	SI-77
Moment Spaces	SI-78
Numerical Analysis	SI-78
Polynomials and Special Functions	SI-80
Probability	SI-81
Transportation Problems and Network Theory	SI-82
Utility Theory	SI-84
War Gaming	SI-84
Meteorology—See also Geophysics and Space Flight	SI-84
Fallout	SI-84
Forecasting and Weather Studies	SI-85
Miscellaneous	SI-85
Upper Atmosphere and Ionosphere	SI-86
Winds	SI-87
Miscellaneous	SI-88
Missiles—See also Aerodynamics and Fluid Mechanics, Bombing, Defense Studies, Navigation, Nuclear Studies, Offense Studies, Operations, Propulsion, Reconnaissance, Reliability, and Structures	SI-89
Ballistic Missiles	SI-89
Miscellaneous	SI-89
Surface-to-surface Missiles	SI-90
Navigation—See also Aircraft, Electronics, Guidance and Control, Missiles, Radar, and Space Flight	SI-90
Nuclear Studies—See also Aircraft, Bombing, Meteorology, Missiles, Physics, and Propulsion	SI-91
Nuclear Physics: Powerplants and Reactors	SI-91
Nuclear Physics: Shielding	SI-91
Nuclear Weapons Basic Studies	SI-92
Nuclear Weapons Effects	SI-92
Nuclear Weapons Employment	SI-93
Nuclear Weapons Phenomenology	SI-93
Translations	SI-94
Offense Studies—See also Aircraft, Bombing, Defense Studies, Missiles, Operations, and Targets	SI-95
Enemy Defense Capabilities	SI-95
Mathematical Models	SI-95
Miscellaneous	SI-95
Targets	SI-96
Weapons and Weapon Systems	SI-96
Operations—See also Aircraft, Bombing, Defense Studies, Logistics, Missiles, Offense Studies, Reconnaissance, and Targets	SI-96
Air Battle	SI-96
Central War	SI-97
Limited War	SI-97
Logistics	SI-98
Miscellaneous	SI-100
Operations Analysis	SI-100
Strategic Warfare	SI-101
Tactical Warfare	SI-101

Operations Research—See Systems Analysis	
Physics—See also Aerodynamics and Fluid Mechanics, Geophysics, and Nuclear Studies . .	SI-102
Astrophysics	SI-102
Atomic Physics: Absorption and Opacity	SI-102
Atomic Physics: Equation of State	SI-103
Atomic Physics: Physical Chemistry	SI-103
Atomic Physics: Plasma	SI-104
Atomic Physics: Solid State	SI-104
Atomic Physics: Thermodynamics	SI-105
Electrodynamics	SI-105
Gas and Fluid Dynamics	SI-106
Mathematical Physics	SI-108
Miscellaneous	SI-109
Physiology	SI-110
Propulsion—See also Aircraft, Missiles, Nuclear Studies, and Space Flight	SI-111
Air-breathing Engines	SI-111
Fuels	SI-111
Miscellaneous	SI-112
Nuclear Devices	SI-112
Rockets	SI-113
Psychology	SI-113
Automata	SI-113
Laboratory Man-Machine Studies	SI-114
Miscellaneous	SI-115
Organization Theory	SI-115
Sleep-learning	SI-116
Radar—See also Bombing, Countermeasures and Counter-countermeasures, Defense Studies, Electronic Environment Studies, Electronics, Guidance and Control, Infrared Studies, and Navigation	SI-116
Detection Theory	SI-116
Miscellaneous	SI-116
Radiological Warfare—See Nuclear Studies, Physiology, and Targets	
Reconnaissance—See also Aircraft, Electronics, Missiles, and Operations	SI-117
Reliability—See also Aircraft, Electronics, and Missiles	SI-117
Social and Political Science—See also Communications	SI-119
Asian Studies	SI-119
Basic Studies	SI-120
Communications and Intelligence	SI-121
Defense Studies	SI-121
French Studies	SI-122
German Studies	SI-122
International Political Context Studies	SI-123
Miscellaneous	SI-124
Psychological and Political Warfare	SI-124
Soviet Ideology	SI-124
Soviet Military Studies	SI-125
Soviet Policy Studies	SI-126
Soviet Political Context Studies	SI-126
Space Flight—See also Aerodynamics and Fluid Mechanics, Applied Mechanics, Guidance and Control, Human Engineering, Meteorology, Navigation, Physics, and Propulsion	SI-128
Interplanetary Flight	SI-128
Lunar Flight	SI-128
Miscellaneous	SI-129
Orbits and Tracking	SI-130
Satellites	SI-131
Space Law	SI-132
Space Operations	SI-132

Statistics—See also Game Theory and Mathematics	SI-133
Distribution Theory	SI-133
Estimation Procedures	SI-134
Miscellaneous	SI-135
Random Sampling	SI-135
Significance Tests	SI-136
Statistical Decision Theory	SI-136
Structures—See also Aircraft and Missiles	SI-137
Design Techniques	SI-137
Fatigue	SI-137
Materials	SI-137
Miscellaneous	SI-139
Weight Estimation	SI-140
Systems Analysis—See also Economics	SI-140
Targets—See also Bombing, Defense Studies, Offense Studies, and Operations	SI-142
Damage Assessment and Criteria	SI-142
Miscellaneous	SI-142
Warfare—See Defense Studies, Offense Studies, Operations, and Targets	

SUBJECT INDEX

AERODYNAMICS AND FLUID MECHANICS—See also Aircraft, Applied Mechanics, Defense Studies, Missiles, Nuclear Studies, Physics, and Space Flight

ATMOSPHERIC RE-ENTRY

- R-273 Heat-transfer Aspects of the Atmospheric Re-entry of Long-range Ballistic Missiles
- RM-1693 Skin Temperature Variation during Re-entry of Scientific Satellite
- RM-1844 A Recoverable Scientific Satellite
- RM-1863-1 An Analysis of the Rotational Motion of a Body during Re-entry
- RM-2523 Similar Solutions of Compressible Laminar-boundary-layer Equations for Binary Mixtures
- RM-2579 Atmospheric Entry of Manned Vehicles
- RM-2932-PR Concerning a Certain Effect in the Field of Meteor Aerodynamics
 - P-135 On the Accuracy of the Long-range Ballistic Rocket
 - P-953 Meteoric Interaction with the Atmosphere: Theory of Drag and Heating and Comparison with Observations
 - P-955 Deceleration and Heating of a Body Entering a Planetary Atmosphere from Space
- P-978 The Atmosphere of Venus
- P-1119 Recovery of a Circum-lunar Instrument Carrier
- P-1322 The Penetration of Planetary Atmospheres
- P-1407 On the Rotational Motion of a Body Re-entering the Atmosphere
- P-1890 Atmospheric Entry of Manned Vehicles
- P-2046 On the Problem of Ballistic Missile Defense
- P-2052 Atmospheric Entry
- P-2218-1 Thermodynamic Properties of Carbon Dioxide to 24,000°K
- P-2436 The Computation of Oblique Shock Wave Characteristics for Real Gases
- P-2456 The Thermodynamic Properties of 85% CO₂ and 15% Nitrogen to 24,000°K

BOUNDARY LAYERS

- RM-1129 Boundary-layer Drag for Nonsmooth Surfaces
- RM-1972 On the Stability of Flow in the Boundary Layer near the Nose of a Blunt Body
- RM-2516 A Review of Binary Boundary Layer Characteristics
- RM-2523 Similar Solutions of Compressible Laminar-boundary-layer Equations for Binary Mixtures
- RM-2638 The Design and Test of a Zero-wave-drag Ring-wing Configuration
- P-50 A Solution of the Laminar Boundary Layer Equations for a Compressible Fluid with Variable Properties Including Dissociation
- P-214 The Compressible Boundary Layer
- P-1172 The High-speed Flow of Gas around Blunt Bodies
- P-1329 Review and Discussion of the Problem of Binary Laminar Boundary Layers—Part I: Stability Considerations
- P-1371 General Characteristics of Binary Boundary Layers with Applications to Sublimation Cooling
- P-1729 A Review of Binary Boundary Layer Characteristics
- P-1730 Effect of Molecular Weight on Mass-transfer Cooling in a Laminar Boundary Layer on a Flat Plate
- P-1732 Mass-transfer Cooling in a Turbulent Boundary Layer
- P-1979 An Approximate Investigation of the Effect of Boundary Layer Control Pumping on Powerplant Performance
- P-2473 A Brief Review of Mass Transfer Cooling
- T-88 Some Special Solutions of the Boundary Layer Equations for a Compressible Fluid
- T-142 The Experimental Investigation of the Subsonic Turbulent Boundary Layer on a Plate with Injection
- T-144 Heat and Mass Exchange with a Solid-gas Phase Change on the Surface of a Body

AERODYNAMICS AND FLUID MECHANICS—continued

DRAG ESTIMATION

- R-339 Aerodynamics of the Upper Atmosphere
- RM-1129 Boundary-layer Drag for Nonsmooth Surfaces
- RM-1201 A Simplified Physical Interpretation of Whitcomb's "Area Rule" for the Reduction of Supersonic Pressure Drag
- RM-2107 Drag Transformation and Reduction for Bodies of Revolution
- RM-2208 Aerodynamic Characteristics and Geometric Properties of Half- and Complete-ring-body Configurations for Supersonic Design Mach Number
- RM-2260 Theoretical Development for Lifting Ring-Body Configurations
- RM-2313 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow with Application to Neutral-particle Drag Estimates of Satellites
- RM-2348 Lift of Slender Nose Shapes According to Newtonian Theory
- RM-2638 The Design and Test of a Zero-wave-drag Ring-wing Configuration
- RM-2678 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow
- P-625 A Simplified Expression for the Dihedral Effect of a Flexible Wing
- P-626 On Use of the General Bending Formula
- P-1496 Atmospheric Perturbations of Artificial Satellites
- P-1520 On the Drag of a Sphere Moving in a Partially Ionized Atmosphere
- P-1609 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow, with Application to Satellite Drag
- P-1611 Secular Variation in the Inclination of the Orbit of Earth Satellite (1957 β) and Air Drag
- P-1659 An Improved Solution for the Motion of Bodies in Free Fall
- P-1830 Drag Coefficients of Small, Irregular Particles
- P-1889 Empirical Relationships for Jet-flap Lift and Drag Prediction
- P-2110 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow

HEAT TRANSFER

- RA-15022 Aerodynamics, Gas Dynamics, and Heat Transfer Problems of a Satellite Rocket
- RA-15077 Short-time, High-temperature Properties of Heat-resisting Alloy Sheet
- R-116 Porous Ceramics for Transpiration Cooling
- R-273 Heat-transfer Aspects of the Atmospheric Re-entry of Long-range Ballistic Missiles
- R-339 Aerodynamics of the Upper Atmosphere
- RM-4 Thermodynamic Properties of Metals
- RM-144 Aerodynamic Heating Relations
- RM-438 Summary Report: Cyclic Heat-transfer Studies with Gases
- RM-1351 Note on the Effect of Circulation in Heat Transfer
- RM-1524 Transient Heat Conduction in Composite Slabs for a Heat Flux Varying Exponentially with Time
- RM-1735 Surface-protection and Cooling Systems for High-speed Flight
- RM-1892 Linearized Solution for Heat Addition at the Surface of a Supersonic Airfoil
- RM-2078 The Production of Aerodynamic Forces by Heat Addition on External Surfaces of Aircraft
- RM-2244 Heat Transfer in a Dissociating Gas
- RM-2292 Thermodynamic Properties of Carbon Dioxide to 24,000°K with Possible Application to the Atmosphere of Venus
- RM-2852-PR Information on the 1961 Minsk Conference on Heat and Mass Transfer with Phase and Chemical Conversions
- RM-2931-PR The Structure of a Shock Wave in Air Taking Account of the Kinetics of Chemical Reactions
- P-50 A Solution of the Laminar Boundary Layer Equations for a Compressible Fluid with Variable Properties Including Dissociation
- P-54 A Method for Measuring Surface Heat Transfer Using Cyclic Temperature Variation
- P-55 A Study of Freely Expanding Inhomogeneous Jets
- P-829 Surface-protection and Cooling Systems for High-speed Flight

- P-852 The Steady, Axially Symmetric Flow of a Viscous Fluid in a Deep Rotating Cylinder Which Is Heated from Below
- P-955 Deceleration and Heating of a Body Entering a Planetary Atmosphere from Space
- P-1256 Aerodynamics for Space Flight
- P-1322 The Penetration of Planetary Atmospheres
- P-1371 General Characteristics of Binary Boundary Layers with Applications to Sublimation Cooling
- P-1612 Heat Transfer from a Nonisothermal Disk Rotating in Still Air
- P-1730 Effect of Molecular Weight on Mass-transfer Cooling in a Laminar Boundary Layer on a Flat Plate
- P-1732 Mass-transfer Cooling in a Turbulent Boundary Layer
- P-2045 The Influence of Prandtl Number on the Heat Transfer from Rotating Non-isothermal Disks and Cones
- P-2046 On the Problem of Ballistic Missile Defense
- P-2218-1 Thermodynamic Properties of Carbon Dioxide to 24,000°K
- P-2473 A Brief Review of Mass Transfer Cooling
- T-15 Some Problems of Flow, Heat Transfer, and Diffusion in the Laminar Flow along a Flat Plate
- T-90 Unified Dynamics and Thermodynamics of a Thermal Plasma
- T-96 Mollier Enthalpy-Entropy Charts for High-temperature Plasmas
- T-99 Equilibria in a Thermal Plasma Composed of $C + H_2$ and $C + 2H_2$ in a Temperature Range from 5000°K to 50,000°K at a Total Pressure of 1 Bar
- T-100 Equilibria in $C + H_2$ and $C + 2H_2$ Systems at Temperatures between 1000°K and 6000°K
- T-140 Calculation of the Heating of Two-layer Plates
- T-144 Heat and Mass Exchange with a Solid-gas Phase Change on the Surface of a Body
- T-145 On the Analysis of Heat and Mass Transfer in Binary Gas Mixtures

HYPERSONIC AERODYNAMICS

- RA-15022 Aerodynamics, Gas Dynamics, and Heat Transfer Problems of a Satellite Rocket
- R-339 Aerodynamics of the Upper Atmosphere
- RM-770 A Hypersonic Approximation of the Pressure Forces on Ogives
- RM-844 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part I: Noses and Cylinders
- RM-905 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part II: Boattails
- RM-1351 Note on the Effect of Circulation in Heat Transfer
- RM-1633 Newtonian Flow Theory for Slender Bodies
- RM-1713 Hypersonic, Nonviscous Flow around a Circular Disk Normal to the Stream
- RM-1772 Hypersonic, Nonviscous Flow around a Sphere
- RM-1991 Sweepback Theory for Shock Waves at Hypersonic Speeds
- RM-2292 Thermodynamic Properties of Carbon Dioxide to 24,000°K with Possible Application to the Atmosphere of Venus
- RM-2313 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow with Application to Neutral-particle Drag Estimates of Satellites
- RM-2348 Lift of Slender Nose Shapes According to Newtonian Theory
- RM-2523 Similar Solutions of Compressible Laminar-boundary-layer Equations for Binary Mixtures
- P-87 Lift on Inclined Bodies of Revolution in Hypersonic Flow
- P-395 On the Stability of Fluid Flows with Spherical Symmetry
- P-723 On the Stability of a Circular Cylinder at Hypersonic Speeds
- P-926 Newtonian Flow Theory for Slender Bodies
- P-930 Hypersonic, Nonviscous Flow around a Circular Disk Normal to the Stream
- P-940 A Simple Relation between the Shock and Expansion Pressure Coefficients for Two-dimensional Hypersonic Flow
- P-1011 A Simple Relationship between the Shock and Expansion Pressure Coefficients as a Basis for Studying Two-dimensional Hypersonic Flow

AERODYNAMICS AND FLUID MECHANICS—continued

HYPERSONIC AERODYNAMICS—continued

- P-1172 The High-speed Flow of Gas around Blunt Bodies
- P-1189 Thin Airfoils in Hypersonic Flow with Strong Shocks
- P-1256 Aerodynamics for Space Flight
- P-1270 Lift of Slender Nose Shapes According to Newtonian Theory
- P-1276 Note on the Lift of Slender Nose Shapes According to Newtonian Theory
- P-1322 The Penetration of Planetary Atmospheres
- P-1337 Sweepback Theory for Shock Waves at Hypersonic Speeds
- P-1371 General Characteristics of Binary Boundary Layers with Applications to Sublimation Cooling
- P-1395 Piston Theory Applied to Strong Shocks and Unsteady Flow
- P-1496 Atmospheric Perturbations of Artificial Satellites
- P-1609 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow, with Application to Satellite Drag
- P-1890 Atmospheric Entry of Manned Vehicles
- P-1994 Tentative Generalization of Leading-edge Viscous Interaction Phenomena
- P-2008 One-dimensional Expansion of a Finite Mass of Gas into Vacuum
- P-2046 On the Problem of Ballistic Missile Defense
- P-2110 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow
- P-2113 Molecular Flow Study of the Hypersonic Sharp Leading Edge Interactions
- P-2266 Free Molecule Flows
- P-2367 Near Free Molecule Flows: Review of Analysis and Results
- P-2418 The Use of Local Similarity Concepts in Hypersonic Viscous Interaction Problems, and Application to Yawed Lifting Surfaces with Mass Transfer
- P-2420 The Effect of Pressure Gradient on the Hypersonic Strong Viscous Interaction on a Flat Plate with Surface Mass Transfer
- P-2436 The Computation of Oblique Shock Wave Characteristics for Real Gases

MAGNETOHYDRODYNAMICS

- R-339 Aerodynamics of the Upper Atmosphere
- RM-1201 A Simplified Physical Interpretation of Whitcomb's "Area Rule" for the Reduction of Supersonic Pressure Drag
- P-1695 Some Interior Problems of Hydromagnetics
- P-1794 Induced Oscillations in a Rarefied Plasma in a Magnetic Field
- P-1827 On One-dimensional Inviscid Magnetohydrodynamic Flow
- P-1890 Atmospheric Entry of Manned Vehicles
- P-1944 Electrical Power from Rockets
- P-2012 Electrical Power from Magnetohydrodynamic (MHD) Generators
- P-2075 Charge Density in the Wake of a Point Charge Traveling in a Plasma
- P-2141 Similarity Solution for Cylindrical Magnetohydrodynamic Shock Waves Produced by a Line Current Which Increases Linearly with Time
- P-2318 Analytic Methods and Approximations of MHD Problems

MISCELLANEOUS

- R-142 Mixing in Inhomogeneous Gas Jets
- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- RM-43 Aerodynamics of Spheres
- RM-71 Tables of Dynamic Pressure
- RM-144 Aerodynamic Heating Relations
- RM-350 The Rayleigh-Ritz Method in Compressible Flow Problems
- RM-436 Tables of Contributions to Thermodynamic Properties Due to Gas Imperfection
- RM-442 Thermodynamic Properties of Real Gases for Use in High-pressure Problems
- RM-1038 The Normal Force and Pressure Distribution on a Flat Plate at Normal Incidence, in the Presence of a Moving Vortex Pair
- RM-1517 Aerodynamic Research Facilities Required for the Development of Moderate and Long-range Ballistic Missiles

- RM-1633 Newtonian Flow Theory for Slender Bodies
- RM-1794 Transport Coefficients of Dissociating and Slightly Ionizing Air
- RM-1939 Fully Cavitating Hydrofoils in Nonsteady Motion
- RM-2078 The Production of Aerodynamic Forces by Heat Addition on External Surfaces of Aircraft
- RM-2208 Aerodynamic Characteristics and Geometric Properties of Half- and Complete-ring-body Configurations for Supersonic Design Mach Number
- RM-2260 Theoretical Development for Lifting Ring-Body Configurations
- RM-2585 A Survey of Thermal Accommodation Coefficients
- RM-2682-1-PR Theory of Ionized Trails for Bodies at Hypersonic Speeds
- RM-2818-PR The Hypersonic Trail in the Expansion-conduction Region
- RM-2852-PR Information on the 1961 Minsk Conference on Heat and Mass Transfer with Phase and Chemical Conversions
- RM-2930-PR An Adiabatic-isothermal Nozzle
- RM-2931-PR The Structure of a Shock Wave in Air Taking Account of the Kinetics of Chemical Reactions
- RM-2932-PR Concerning a Certain Effect in the Field of Meteor Aerodynamics
- P-174 On an Equation Occurring in the Harmonic Analysis of Viscous Fluid Flow
- P-695 Calculation of Hydrofoil Sections from Prescribed Pressure Distributions
- P-852 The Steady, Axially Symmetric Flow of a Viscous Fluid in a Deep Rotating Cylinder Which Is Heated from Below
- P-1921 The Vertical Motion of Solid Spheres in the Atmosphere
- P-2244 Ionization Trails
- P-2350-1 Munk Integrals for Fully Cavitating Hydrofoils
- RAT-3 Discussions on High-speed Aerodynamics
- RAT-12 The Effect of Compressibility on the Laminar Boundary Layer of a Flat Plate
- T-15 Some Problems of Flow, Heat Transfer, and Diffusion in the Laminar Flow along a Flat Plate
- T-18 Excerpt from "Motion of Compressible and Incompressible Fluids"
- T-57 On Certain Unsteady Motions of a Compressible Fluid
- T-74 On the Problem of a Streamlined Profile in a Near-sonic Flow
- T-138 Sublimation near the Stagnation Point of an Axisymmetrical Blunt Body
- T-139 Calculation of Required Thrust Taking into Account Compressibility

STABILITY AND CONTROL

- RM-1972 On the Stability of Flow in the Boundary Layer near the Nose of a Blunt Body
- P-135 On the Accuracy of the Long-range Ballistic Rocket
- P-654 An Aeroelastic Parameter for Estimation of the Effects of Flexibility on the Lateral Stability and Control of Aircraft
- P-898 The Response of a Bisymmetric Aircraft to Small Combined Pitch, Yaw, and Roll Control Actions
- P-1329 Review and Discussion of the Problem of Binary Laminar Boundary Layers—Part I: Stability Considerations
- P-1484 A General Theorem Concerning the Stability of a Particular Non-Newtonian Fluid
- T-16 Some Questions of Aerodynamic Damping and Dynamic Stability

SUPERSONIC AERODYNAMICS

- RA-15073 Eighth Quarterly Report—App. I: Materials, Fuels, and Combustion Project
- R-141 A Two-dimensional Airfoil in Unsteady Supersonic Flow
- R-142 Mixing in Inhomogeneous Gas Jets
- R-149 The Composition and Thermodynamic Properties of Air at Temperatures from 500 to 8000°K and Pressures from 0.00001 to 100 Atmospheres
- RM-48 An Elucidation of Stone's Solution for a Slightly Yawing Supersonic Cone
- RM-113 Evaluation of Materials in the Elasto-plastic Range
- RM-702 The Axial Pressure Force on an Inclined Body of Revolution in Supersonic Flow
- RM-844 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part I: Noses and Cylinders

AERODYNAMICS AND FLUID MECHANICS—continued

SUPERSONIC AERODYNAMICS—continued

- RM-905 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part II: Boattails
 - RM-992 Inviscid Aerodynamics of Missiles with Noncircular Cross Sections
- RM-1735 Surface-protection and Cooling Systems for High-speed Flight
- RM-1892 Linearized Solution for Heat Addition at the Surface of a Supersonic Airfoil
- RM-1972 On the Stability of Flow in the Boundary Layer near the Nose of a Blunt Body
- RM-2078 The Production of Aerodynamic Forces by Heat Addition on External Surfaces of Aircraft
- RM-2107 Drag Transformation and Reduction for Bodies of Revolution
- RM-2208 Aerodynamic Characteristics and Geometric Properties of Half- and Complete-ring-body Configurations for Supersonic Design Mach Number
- RAOP-23 The Design of Constant-volume Missile Fuselages Having Minimum Drag at Supersonic Speeds
- P-101 Transtability Flutter of Supersonic Aircraft Panels
- P-125 First- and Second-order Theory of Supersonic Flow Past Bodies of Revolution
- P-198 Supersonic Flow around Cones at Large Yaw
- P-813 The Optimum Distribution of Lift in Certain Prismatic Regions at Supersonic Speed
- P-1069 Supersonic Flow around Blunt Bodies
- P-1539 Supersonic Transports
- RAT-1 Optimum Shapes for Axially Symmetrical Supersonic Thrust Nozzles
- RAT-4 Monograph on the Theory of Characteristics
- RAT-6 The Laminar Boundary Layer on a Cone in a Supersonic Air Stream at Zero Angle of Attack
- RAT-8 Cones in Supersonic Flow
- T-120 Calculation of the Flight Characteristics of a Supersonic Airplane with Turbojet Engines
- T-139 Calculation of Required Thrust Taking into Account Compressibility

AEROPHYSIOLOGY—See Physiology

AIRCRAFT—See also Aerodynamics and Fluid Mechanics, Bombing, Logistics, Navigation, Offense Studies, Operations, Propulsion, Reconnaissance, Reliability, and Structures

BOMBERS

- RA-15008 Effect on Military Worth of Exchanging Bombing Accuracy for Bomber Safety by Increasing Range of Bomb
- RA-15018 Factors Limiting the Operational Gross Weight of the B-17 and B-29 Bombardment Airplanes: App. III to Fourth Quarterly Reports, RA-15033 and RA-15034
- RA-15068 Propellers for High-speed Long-range Airplanes
- RM-193 A Bomber-Fighter Duel—II
- RM-239 Air Battle Theory: Statistical Survival Analysis for Close-controlled Interceptors versus Bombers
- RM-240 Basic Survival-probability Expressions for Air Combat Models
- RM-286 Pursuit Path Method: Maneuvering Bomber
- RM-400 Two-airplane Formation Design: Generalized Theory
- RM-536 Cost-Quality Relations in Bomber Airframes
- RM-1297 Analysis of the Demand Patterns for B-47 Airframe Parts at Air Base Level
- RM-1300 Predictability of Demand for B-47 Airframe Spare Items
- RM-1415 A Two-machine-gun Duel with the Bomber Turret Vulnerable

CAPABILITIES AND PERFORMANCE

- RA-15005 The Interim Study

- RA-15016 An Analysis of the Guided Missile—Strategic Bomber Interception Problem: App. II to Fourth Quarterly Reports, RA-15033 and RA-15034
- R-382 Influence of Resource and Policy Changes on Aircraft Capabilities
- RM-100 A General Problem in the Calculus of Variations with Applications to Paths of Least Time
- RM-245 Climb Path for Least Elapsed Time
- RM-310 Performance Effects of Refueling
- RM-453 Performance Effects of Double Refueling
- RM-456 Methodology Problems in Airframe Cost-Performance Studies
- RM-1179 Preliminary Study of Turbojets for Mach 2.75
- RM-1571 The Significance of Major Cycle Variables on Turbojet Engine Performance at Mach 3.0
- RM-1664 A Brief Investigation of the Possibility of Increasing the Range of Aircraft by Dropping Unnecessary Parts in Flight
- RM-1710 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
- RM-1759 A New Approach to the Military Budget
- RM-1807 A Method for Estimating Engine Failure Rates
- RM-2415 The Flight Operations Planner
- RM-2525 Addendum of RM-2415, *The Flight Operations Planner*
- RM-2638 The Design and Test of a Zero-wave-drag Ring-wing Configuration
- P-654 An Aeroelastic Parameter for Estimation of the Effects of Flexibility on the Lateral Stability and Control of Aircraft
- P-834 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
- P-898 The Response of a Bisymmetric Aircraft to Small Combined Pitch, Yaw, and Roll Control Actions
- P-1178 An Airborne Collision-warning Device
- P-1519 A Consideration of Fuels for Future Air Transportation Systems
- P-1979 An Approximate Investigation of the Effect of Boundary Layer Control Pumping on Powerplant Performance
- P-2049 Low Cost Cargo Aircraft: Turboprop or Turbofan?
- T-139 Calculation of Required Thrust Taking into Account Compressibility

FIGHTERS AND INTERCEPTORS

- RM-193 A Bomber-Fighter Duel—II
- RM-233 Application of Concepts from Kinetic Theory of Gases to Interception Problem
- RM-240 Basic Survival Probability Expressions for Air Combat Models
- RM-246 A Study To Determine the Flight Paths Which Require Minimum Time and Minimum Fuel for a Typical Present-day Interceptor
- RM-316 Maneuvering and Scanning Barriers for All-weather Interceptions: A Graphical Method
- RM-399 Attack of Single-bomber Aircraft
- RM-575 Conversion of Interceptor Design Parameters and Cost to Air Battle Parameters for a 1954–1958 Air Battle Analysis
- RM-1867 Design Change Impacts on Airframe Parts Inventories

MISCELLANEOUS

- RA-15039 Ceramic Materials Research for Aircraft and Rocket Vehicles
- RA-15056 Ceramic Materials Research in the United Kingdom for Aircraft and Rocket Vehicles
- R-104 An Appraisal of the Usefulness of Aluminum Alloys for Supersonic Aircraft and Guided Missile Construction
- R-117 An Evaluation of Ceramic Materials for Aircraft and Rocket Vehicles
- R-130 An Approximate Method for the Calculation of Airplane Radius Factor
- R-222 Weight-Strength Analysis of Aircraft Structures
- R-292 Characteristics of Demand for Aircraft Spare Parts
- RM-198 Economic Survey Report: Construction Materials for Aircraft and Guided Missiles, Electric Power Supply and Requirements
- RM-245 Climb Path for Least Elapsed Time

AIRCRAFT—continued

MISCELLANEOUS—continued

- RM-310 Performance Effects of Refueling
- RM-391 Derivation of a Wing Weight Formula for a Thin Wing Structure
- RM-453 Performance Effects of Double Refueling
- RM-464 Comments on the Modified Form of Aircraft Progress Function
- RM-612 Radius Extension Effects of Refueling a Bomber by Dissimilar Tankers
- RM-797 Desirability of In-the-air Overloading of Aircraft
- RM-1198 Proposal for Reduction of Factors of Safety for Military Airplanes
- RM-1334 The Effects of Reversed Thrust on Landing Distance
- RM-1360 The Desirability of Revising Aircraft Form 1
- RM-2127 A Criterion for Choosing Sheet Tolerances in Aircraft Materials
- RM-2260 Theoretical Development for Lifting Ring-Body Configurations
- RM-2322 Evaluation of the Effect of Environment on Refueling Operations
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- P-1353 General Description of a Cooperative Anticollision System for Aircraft
- P-1889 Empirical Relationships for Jet-flap Lift and Drag Prediction
- P-2037 The Commercial Aircraft Bomb Hazard: A Possible Answer
- P-2331 Historical Note on the 1.5 Factor of Safety for Aircraft Structures
- P-2479 Aviation and International Relations
- T-46 *Red Star* on Refueling Aircraft in the Air
- T-55 The Russian Atomic Airplane of the Future
- T-106 On an Atomic Airplane

RANGE EXTENSION

- R-114 Effects of Flight Speed and Propulsive System on Aircraft Range
- R-130 An Approximate Method for the Calculation of Airplane Radius Factor
- RM-239 Air Battle Theory: Statistical Survival Analysis for Close-controlled Interceptors versus Bombers
- RM-453 Performance Effects of Double Refueling
- RM-612 Radius Extension Effects of Refueling a Bomber by Dissimilar Tankers
- RM-797 Desirability of In-the-air Overloading of Aircraft
- RM-1664 A Brief Investigation of the Possibility of Increasing the Range of Aircraft by Dropping Unnecessary Parts in Flight
- RM-1868 Fibered Materials for Flight Structures
- RM-2322 Evaluation of the Effect of Environment on Refueling Operations

TRANSPORTS AND SUPPORT AIRCRAFT

- △ ● R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes
- R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes: Turbofan Engine Supplement
- RM-224 A Mathematical Model of an Air Transportation System
- RM-1380 Cargo Density and Air Transportation
- RM-1853 Cargo Density and Airlift
- RM-2327 Military Supersonic Transports
- RM-2566 Aircraft Compartment Design Criteria for the Army Deployment Mission
- P-533 Air Cargo Transport Scheduling: An Illustrative Block Triangular System
- P-1539 Supersonic Transports
- P-1575 Some Military Aspects of Supersonic Transports
- P-1655 Design and Cost Considerations for High-altitude Aircraft Systems
- P-1826 A Structural Approach to Military Air Transportation
- P-1882 A Model for Evaluating Fleets of Transport Aircraft
- P-2037 The Commercial Aircraft Bomb Hazard: A Possible Answer
- P-2049 Low Cost Cargo Aircraft: Turboprop or Turbofan?
- P-2076 Compatibility of Military and Commercial Airlift Requirements
- P-2082 Aircraft Compartment Design Criteria for the Army Deployment Mission
- P-2486 Air Transport and Economic Development: Some Comments on Foreign Aid Programs

APPLIED MECHANICS—See also Aerodynamics and Fluid Mechanics, and Space Flight

FLIGHT AND CELESTIAL MECHANICS

- RA-15021 Flight Mechanics of a Satellite Rocket
- RM-1641 Graphical Determination of Ballistic Trajectories: Through Outer Space with Compass and Straightedge
- RM-1728 Lunar Instrument Carrier: Trajectory Studies
- RM-2643 Oblateness Perturbations of Near-earth Satellites
- RM-2671 A Method for Determining Approximate Propulsion Cutoff Conditions for Ballistic Interplanetary Trajectories
- RM-2881-PR Some Methods for Establishing Interplanetary Transfer Orbits
 - P-1171 The Maser: A New Type Molecular Amplifier for Microwave Radiation
- P-1292 A Proposed Stagewise Differential Correction Procedure for Satellite Tracking and Prediction
- P-1303 Trajectory Fundamentals
 - P-1387 Space Flight Trajectories, Navigation, and Maneuvers
 - P-1407 On the Rotational Motion of a Body Re-entering the Atmosphere
 - P-1453 Lunar Flight Dynamics
 - P-1496 Atmospheric Perturbations of Artificial Satellites
- P-1737 Tables of True Anomaly versus Time Interval for Keplerian Orbits
- P-1864 Ascent Guidance for a Satellite Rendezvous
- P-1915 Celestial Frontiers
- P-1968 A Computer Program for First-order-error Propagation in Satellite-orbit Prediction
- P-2002 Effect of Geometrical Libration on the Damped Motion of an Earth Satellite
- P-2038 Low-acceleration Transfer Orbits
 - P-2177-1 The Optimization of Multi-stage Orbit Transfer Processes by Dynamic Programming
- P-2285 A Method for Determining Approximate Initial Conditions for Interplanetary Trajectories
- P-2343-1 Equations of Perturbed Motion for Low-eccentricity Orbits
- T-85-PR The Determination of Orbits
- T-118 The Approximate Calculation of an Ephemeris in Unperturbed Elliptic Motion
- T-119 Concerning the Approximate Calculation of an Ephemeris in the Restricted Problem of Three Bodies
- T-120 Calculation of the Flight Characteristics of a Supersonic Airplane with Turbojet Engines

HIGH-SPEED IMPACT

- RM-1181 A Theoretical Treatment of Spalling
- RM-1707 The Atomic-Hydrogen Gun
- RM-2332 Estimated Damage to Space Vehicles by Meteoroids
 - P-785 The Impact Theory of the Origin of Lunar Craters
 - P-836 The Impact of Large Meteorites
 - P-1662 Effects of a Meteoroid Impact on Steel and Aluminum in Space
 - P-1913 A Conservative Estimate of the Meteoroid Penetrating Flux
 - P-1936 Comments on "The Effect of Micrometeorites on Reflecting Surfaces"
 - P-1963 Meteoroids versus Space Vehicles
 - P-2172 Meteoroid Hazard to Nuclear Power Stations in Space

MISCELLANEOUS

- RM-2011 On the Strength of Fine Wires
- P-274 Thermal Stresses in a Partially Clamped Elastic Half-plane
- P-304 Thermal Stresses in Conical Shells
 - P-359 Constant-strain Waves in Strings
- P-467 Impulsive Loading on an Elastic Half-plane
 - P-541 A Note on Plastic Torsion
- P-614 Elastic Stress Waves Produced by Pressure Loads on a Spherical Shell
- P-633 A Similarity Solution for a Spherical Shock Wave
- P-664 A General Transformation for Orthotropic Plane Stress and Plane Strain Problems

APPLIED MECHANICS—continued

MISCELLANEOUS—continued

- P-746 A New Approach to Penetration Mechanics
- P-832 The Nature of Axisymmetric Wave Fields in Elastic Solids
- P-884 Elastic Stresses Produced in a Half Plane by Steadily Moving Loads
- P-1498 Surface Displacements in an Elastic Half-space
- P-1505 Dilatational Surface Waves in an Elastic Half-space
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
- P-2365 Wave-induced Motions of a Large Rocket Vehicle Drifting in a Vertical Attitude
- T-34 Shock Waves in Isotropic Elastic Media
- T-49 On Waves of Loading and Unloading, Arising from the Motion of an Elastic or Plastic Flexible Fibre
- T-56 The Fluid Half Space under a Mechanical Influence on Its Surface (Two-dimensional Problem)
- T-59 The Elastic Half Space under a Mechanical Disturbance of Its Surface (Two-dimensional Problem)

WAVE PROPAGATION

- RM-819 Shock Wave Interaction, or the Velocity Effect in H.E. Rounds
- RM-848 Note on Directional Effects of Pressure Field of Moving Blast
- RM-1435 A Similarity Solution for a Spherical Shock Wave
- RM-1762 Estimating Ground Motions Resulting from Air-induced Ground Shocks
- RM-1967 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface
- RM-1991 Sweepback Theory of Shock Waves at Hypersonic Speeds
- RM-2931-PR The Structure of a Shock Wave in Air Taking Account of the Kinetics of Chemical Reactions
- P-582 The Blast from a Sphere of High-pressure Gas
- P-801 Application of the Baldwin Crater Relation to the Scaling of Explosion Craters
- P-1141 The Complete Solution for an Elastic Half-space under a Point Step Load
- P-1173 Progress Report on Axisymmetric Wave Fields
- P-1210 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface
- P-1650 The Interpretation and Computation of Axisymmetric Head Waves
- P-2046 On the Problem of Ballistic Missile Defense
- P-2066 Surface Waves in an Elastic Half-space
- P-2109 Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium
- P-2212 Load Moving with Super-seismic Speed over a Layered Elastic Solid

ASTROPHYSICS—See Physics and Space Flight

BOMBING—See also Aircraft, Defense Studies, Missiles, Nuclear Studies, Offense Studies, Operations, Radar, and Targets

DAMAGE ANALYSES

- RM-274 Determination of Expected Coverage and of Expected Damage: Single Bomb of Large Lethal Area
- RM-323 On the Expected Damage from Single Bomb Drops
- RM-517 Expected Results of a Bombing Strike, Including Reconnaissance
- RM-522 Curves Giving Expected Results of a Bombing Strike
- RM-810 Expected Damage from One Bomb to a Circular Ring
- RM-857 A Model for Partial Damage to Point Targets
- RM-1632 Expected Damage from Single and Multiple Bombs to Targets Distributed Uniformly around a Circle
- RM-1680 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Motion of Liquid Surface in an Open Rectangular Tank
- RM-1967 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface

- RM-1969 Radioactive Contamination from a Multibomb Campaign
- RM-2715 Structures under Repeated Blast Loadings
- RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-1210 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options
- P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-2414 Problems of Fire in Nuclear Warfare

MISCELLANEOUS

- RA-15008 Effect on Military Worth of Exchanging Bombing Accuracy for Bomber Safety by Increasing Range of Bomb
- RA-15074 Evaluation of Missile Drift Caused by Wind
- RM-677 The Determination of Decision Regions for a Simplified Two-plane Bombing Model
- RM-684 Decision Functions for Bombing Models
- RM-913 Aerial Bombing Tactics: General Considerations (A World War II Study)
- RM-1762 Estimating Ground Motions Resulting from Air-induced Ground Shocks
- RM-2471 A Preliminary-design Aid for Studying Component Weight Assignments in Ballistic-missile Payloads
- P-884 Elastic Stresses Produced in a Half Plane by Steadily Moving Loads
- P-1839 Ballistic-missile Payload Allocation
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
- P-2037 The Commercial Aircraft Bomb Hazard: A Possible Answer

TARGET COVERAGE PROBLEMS

- R-234 Offset Circle Probabilities
- RM-133 Expected Overlap
- RM-134 An Approximate Solution for a Coverage Problem
- RM-145 Target Coverage
- RM-163 Area Coverage with Ordinary Bombs
- RM-177 On the Usefulness of Artificial Dispersion for a Certain Bombing Problem
- RM-189 Note on Some Historic Principles of Target Selection
- RM-191 Expected Coverage When All Bombs Are Aimed at the Center of the Target
- RM-227 Photoelectric Coverage Machine
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-252 Composite Targets: n Identical Elements
- RM-274 Determination of Expected Coverage and of Expected Damage: Single Bomb of Large Lethal Area
- RM-306 Expected Coverage with Conventional Bombs When Rectangular Patterns Are Employed against Rectangular Targets
- RM-309 A Circular Probability Grid
- RM-317 Application of the Photoelectric Machine: Expected Damage by a Single Weapon
- RM-323 On the Expected Damage from Single Bomb Drops
- RM-330 The Circular Coverage Function
- RM-413 The Expected Coverage of a Small Circular Target by a Number of Circular Bombs
- RM-727 The Use of Experts for the Estimation of Bombing Requirements: A Project Delphi Experiment
- RM-810 Expected Damage from One Bomb to a Circular Ring
- RM-857 A Model for Partial Damage to Point Targets
- RM-1985 A Vulnerability Model for Weapon Sites with Interdependent Elements
- RM-2765-PR Some Characteristics of the Elliptic Gaussian Distribution
- P-94 Integral of the Gaussian Distribution over an Offset Ellipse
- P-1384 A Vulnerability Model for Weapon Sites with Interdependent Elements
- P-1678 An Approximating Algorithm for an Optimum Aim-points Problem
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
- P-2178 Note on the Existence of Perfect Maps
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options

CENTRAL WAR—See Operations

COMMUNICATIONS—See also Electronics, and Social and Political Science

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-335 A Study of the Factors Affecting the Choice of Frequency for an Airborne Microwave Relay System
- RM-454 The Theory of Information
- RM-1029 Transmission of Pulses over Voice-quality Telephone Lines
- RM-1687 Communication Networks—I: Optimal Design and Utilization
- RM-1688 Communication Networks—II: Interoffice Trunking Problems
- RM-2057-2 A Preliminary Examination of Single-sideband Communications
- RM-2124 A Comparison of Random and Periodic Data Sampling for the Detection of Signals in Noise
- RM-2169 An Identification System for Use as an Aid to Raid Detection and Air Traffic Control
- RM-2189 Some Applications of Dynamic Programming to Communication and Information Theory
- RM-2259 On the Growth of Duty Cycle in Intermittent Communication Systems
- RM-2445 Descriptive Guide to a Card Directory of U.S. Military Radio Communication Equipment
- RM-2625 Some Results on New Classes of Matched Filters
- RM-2627-PR Cost of a Hardened, Nationwide Buried Cable Network
- RM-2764 Industrial Equipment Spectrum Signatures
- RM-2987-PR Approximate Band-pass Limiter Envelope Distributions
- RM-3024-PR Error Burst Chains in Data Transmission
- RM-3075-PR Expected Critical Path Lengths in PERT Networks
- RM-3080-PR The Analytic Signal Representation of Modulated Waveforms
- P-167 On the Definition of Information
- P-201 The Game of "Gossip" Analyzed by the Theory of Information
- P-217 Methodology for Communications Research
- P-529 Observations on the Growth of Information-processing Centers
- P-587 Social Interaction
- P-599 Communicating Research Results
- P-782 Optimal Design and Utilization of Communication Networks
- P-844 Optimal Utilization and Extension of Interoffice Trunking Facilities
- P-949 On the Role of Dynamic Programming in Statistical Communication Theory
- P-964 General Systems Approaches to Telecommunication Optimization Problems
- P-1194 On Communication Processes Involving Learning and Random Duration
- P-1200 Weighted PCM
- P-1221 Approximate Evaluation of an Expression Arising in the Theory of Time-delay Estimation
- P-1223 On Weighted PCM and Mean Square Deviation
- P-1228 The Utility of a Communication Channel and Applications to Suboptimal Information-handling Procedures
- P-1305 Propagation Considerations in Space Operations
- P-1318 A Discussion of Energy Sources for Space-communications
- P-1325 On Some Communication Network Problems
- P-1339 The Writer, the Editor, the Publisher, and the Reader
- P-1393 Some Information-theory Considerations in Space Communications
- P-1394 Communications in Space Operations
- P-1403 VHF and UHF Communication Antennas
- P-1443 Space Communications
- P-1642 A Comparison of Random and Periodic Data Sampling for the Detection of Signals in Noise
- P-1657 Protection of Communications and Electronic Systems

- P-1673 Recurrent Events in a Bernoulli Sequence
- P-1675 Why Go Deep Underground?
- P-1677 Codes for the Correction of "Clustered" Errors
- P-1684 A Note on the Computation of Single-sideband Peak Power
- P-1724 Military Radio Communications Equipment Trade-offs
- P-1761 Model of Impulsive Noise for Data Transmission
- P-1775 The Effect of Delay Distortion on Data Transmission
- P-1893 The Optimum Detection of Analog-type Digital Data
- P-1931 Wireline Data Transmission
- P-1973 Dynamic Programming, Sequential Estimation, and Sequential Detection Processes
- P-1983 Model of Error Burst Structure in Data Transmission
- P-1995 Reliable Digital Communications Systems Using Unreliable Network Repeater Nodes
- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts
- P-2067 Synchronization of Coherent Detectors
- P-2080 Paradoxes Related to the Rate of Transmission of Information
- P-2105 Statistics of Hyperbolic Error Distributions in Data Transmission
- P-2106 Semi-coherent Detection
- P-2186 The Compression of Finite Discrete Messages
- P-2216 The Economic Potential of Communication Satellites
- P-2279 A Logician's View of Language Data Processing
- P-2301-1 Approximations of K^{th} Order to Coherent Detection
- P-2314 Aspects of Synchronous Communication Satellites
- P-2359 Overlapping Tessellated Communications Networks
- P-2371 Minimal k -Arc-connected Graphs
- P-2377-1 Path-invariant Comma-free Codes
- P-2395 Broadcasting from Satellites
- P-2396 Economic Aspects of Communication Satellite Systems
- P-2466 The Use of War Games in Command and Control Analysis
- P-2520 The Inhuman Style
- P-2522 Western Electronic Show and Convention (WESCON), San Francisco, California, 1961
- P-2536 On the Output Probability Density Function of a Linear Device with Certain Non-gaussian Random Inputs
- T-92 Theory and Applications of the Notion of Complex Signal
- T-109 Radiointerference Phenomena Caused by the Ionosphere of the Moon

COMPLEX INFORMATION PROCESSING

- RM-2506 The Simulation of Human Thought
- RM-2601 Automatic Indexing: An Experimental Inquiry
- RM-3007-PR Studies in the Theory of Computational Algorithms—1: Formalization, Computability, Representation, and Analysis Problems
- RM-3010-PR Data Description for DETAB-X (Decision Table, Experimental)
- RM-3011 Mechanisms Underlying Predictive Behavior for an Intelligent Machine
- P-620 The Chess Machine: An Example of Dealing with a Complex Task by Adaptation
- P-868 The Logic Theory Machine: A Complex Information Processing System
- P-951 Empirical Explorations of the Logic Theory Machine: A Case Study in Heuristics
- P-954 Programming the Logic Theory Machine
- P-971 Elements of a Theory of Human Problem Solving
- P-987 Problem Solving in Humans and Computers
- P-1277 A Command Structure for Complex Information Processing
- P-1319 Chess-playing Programs and the Problem of Complexity
- P-1320 The Processes of Creative Thinking
- P-1356 On "Heuristic Problem Solving" by Simon and Newell
- P-1584 Report on a General Problem-solving Program
- P-1708 What Have Computers To Do with Management?

COMPLEX INFORMATION PROCESSING—continued

- P-1734 The Simulation of Human Thought
- P-1742 A Variety of Intelligent Learning in a General Problem Solver
- P-1799 Summary of a Heuristic Line Balancing Procedure
- P-1817 An Information Processing Theory of Verbal Learning
- P-1820 An Experiment in Chess Playing by Machine
- P-1929 An Introduction to Information Processing Language V
- P-1946 On Programming a Highly Parallel Machine To Be an Intelligent Technician
- P-1993 A Heuristic Program for Assembly-line Balancing
- P-2114-1 Attitudes toward Intelligent Machines
- P-2127 The Use of Heuristic Programming in Management Science
- P-2142 New Areas of Application of Computers
- P-2156 Decisionmaking under Uncertainty and Problem Solving: A Gestalt Theoretical View-point
- P-2170 Toward Intelligent Machines
- P-2180 Automatic Indexing: An Experimental Inquiry
- P-2221 Modeling Human Mental Processes
- P-2235 The Simulation of Verbal Learning Behavior
- P-2257 GPS: A Program That Simulates Human Thought
- P-2258 Why We Cannot Build "Thinking Machines" (At Least at Present)
- P-2276 Computer Simulation of Human Thinking
- P-2311 Forgetting in an Association Memory
- P-2312 Computer Simulation of Human Thinking and Problem Solving
- P-2319 Some Limitations of Automatic Test Equipment
- P-2322 The Use of Manned Simulation in the Design of an Operational Control System
- P-2349 Experiments with a Heuristic Compiler
- P-2358 Performance of a Reading Task by an Elementary Perceiving and Memorizing Program
- P-2375 A Theory of the Serial Position Effect
- P-2437 Development of a Business Language
- P-2442 The Resolution of Cognitive Conflict under Uncertainty: A Critique
- P-2447 Systematic Methods for Programming Simplification
- P-2449 Operations Useful for Similarity-invariant Pattern Recognition
- P-2454 Can EDP Be Applied to All Police Agencies?
- P-2455 Information Retrieval: A Look at the Logical Framework and Some New Concepts
- P-2471 Probability and the Library Problem
- P-2492 Data Processing for Cities
- P-2572 Design Principles for an Intelligent Machine
- T-126 A Comparison of the Theoretically Possible and Actual Procedures Used in Problem Solving

COST ANALYSIS STUDIES—See also Economics and Logistics

BUDGETING

- R-254 Efficiency and Economy in Government through New Budgeting and Accounting Procedures
- RM-1759 A New Approach to the Military Budget
- P-1803 The Federal Budget as an Indicator of Government Intentions and the Implications of Intentions
- P-2255 How Arms Controls Would Affect the National Security Budget
- P-2336 The Role of the Military Comptroller in Defense Management

COST METHODOLOGY

- R-287 Weapon-system Cost Methodology
- R-291 Cost-Quantity Relationships in the Airframe Industry
- RM-260-1 Reliability of Progress Curves in Airframe Production
- RM-456 Methodology Problems in Airframe Cost-Performance Studies
- RM-464 Comments on the Modified Form of Aircraft Progress Function

- RM-481 Reliability of Cost Estimates: Some Evidence
- RM-1199-1 Distribution of Indirect Costs: A Method of Allocating the Cost of Air Force Interdependent Support Activities to Mission Activities
- RM-2144 Factors Affecting the Experience Composition of Airmen in USAF Job Categories: A Mathematical Approach
- RM-2587 An Application of a Network Flow Model to Personnel Planning
- RM-2611 Concepts for Estimating Air Force Manpower Requirements for Planning Purposes
- RM-2695 System and Total Force Cost Analysis
- RM-2786-PR Cost-Quantity Calculator
- RM-2975-PR Military Systems Cost Analysis: A Summary Lecture for the AFSC Cost Analysis Course
- P-267 Use of the Learning Curve
- P-511 Allocation of Indirect Costs
- P-689-RC Criteria for the Selection of Water-resource Projects
- P-794 Weapon System Cost Analysis
- P-820 The Relevance of Costs in Operations Research
- P-823 Weapon-system Cost Analysis
- P-1182 Concepts of Cost for Use in Studies of Effectiveness
- P-1193 A Concept of Stability in Manpower Planning
- P-1492 The Progress-curve Computer
- P-1493 Toward a New Weapon-system Analysis

MISCELLANEOUS

- RM-536 Cost-Quality Relations in Bomber Airframes
- RM-730 Time, Equipment, and Costs To Repair Cratered Runways
- RM-1002 The Cost of Unreliability of Air Force Airborne Electronic Equipment as Represented by the Cost of Maintenance
- RM-1380 Cargo Density and Air Transportation
- RM-1474 The Value of American Manufacturing Plant and Equipment
- RM-1519 A Model of the Procurement-Repair Decision for a Spare Item
- RM-2157 The Big Squeeze, or the Utility of the Heavy Presses
- RM-2206-RC Some Specific Suggestions for Achieving Early Non-military Defense Capabilities and Initiating Long-range Programs
- RM-2627-PR Cost of a Hardened, Nationwide Buried Cable Network
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- P-517 Compensation for War Damage: An Economic View
- P-519 War Damage Insurance
- P-546-RC Cold Water on Salt Water
- P-611 The Cost of Alternative Air Base Stocking and Requisitioning Policies
- P-694 The Role of Management Tools in Making Military Decisions
- P-724 Cargo Density Variations: A Challenge to Air Transport
- P-1197 Federal Spending for National Security
- P-1240 Lead-time in Modern Weapons
- P-1347 A Marginal Cost Function for Highway Construction and Operation
- P-1462 Economics of Defense Procurement and Small Business
- P-1539 Supersonic Transports
- P-1589 Economic Considerations of Space Flight Ground Support Requirements
- P-1639 Sources, Availability, and Estimated Costs of Propellants
- P-1744 Government Efficiency and the Military "Buyer-Seller" Device
- P-1779 What Do We Mean by "Research and Development"?
- P-1821 Predictability of the Costs, Time, and Success of Development
- P-1828 Peak Loads and Efficient Pricing: A General Solution and a Practical Approach
- P-1904 Economic Development and the Employment of Resources
- P-1942 Some Analytical Techniques for Personnel Planning
- P-1975 Economic Aspects of Developing and Orbiting a Space Station

COST ANALYSIS STUDIES—continued

MISCELLANEOUS—continued

- P-2001 Toward a New System for Allocating the Cost of Capacity
- P-2065 A Model Punched Card System for Production Control
- P-2135 Identifying R&D: A Management Problem
- P-2216 The Economic Potential of Communication Satellites
- P-2222 New Tools for Planners and Programmers
- P-2336 The Role of the Military Comptroller in Defense Management
- P-2383 Anyone for the Moon?
- P-2445 The Role of the Accountant in Operations Analysis
- P-2489 The Journey-to-Work as a Determinant of Residential Location
- P-2497 Automatic Data-processing for Production Control
- P-2567 Economic-physical Trade-offs in Scheduling Missile System Checkouts
- P-2568 Technological Change and Local Economy

WEAPON SYSTEM COST ESTIMATES

- R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes: Turbofan Engine Supplement
- RM-3014-PR When To Stop Sampling and Initiate Product Improvement
- P-1655 Design and Cost Considerations for High-altitude Aircraft Systems
- P-1724 Military Radio Communications Equipment Trade-offs
- P-2021 Weapon System Cost Sensitivity Analysis as an Aid in Determining Economic Resource Impact
- P-2302 Maintenance Scheduling Decisions and the Importance of Information

COUNTERMEASURES AND COUNTER-COUNTERMEASURES—See also Defense Studies, Electronics, Infrared Studies, and Radar

- RM-202 Total Reconnaissance with Total Countermeasures: Simplified Model
- RM-208 Reconnaissance in Game Theory
- RM-1643 On the Problem of Determining the Position of a Target with Constant Signal in the Presence of Circuit Noise or Chaff
- RM-2625 Some Results on New Classes of Matched Filters
- P-106 Total Reconnaissance with Total Countermeasures: Simplified Model
- P-1976 The Far-field Back-scattering from a Concave Corner of a Body of Revolution

DEFENSE STUDIES—See also Aircraft, Bombing, Countermeasures and Counter-countermeasures, Infrared Studies, Missiles, Offense Studies, Operations, Radar, and Targets

BASES

- RM-730 Time, Equipment, and Costs To Repair Cratered Runways
- RM-2660 Pressure Response within an Enclosure Subject to a Blast Wave
- RM-2715 Structures under Repeated Blast Loadings
- P-301 Are We Sure about Dispersal?
- P-1384 A Vulnerability Model for Weapon Sites with Interdependent Elements
- P-1877 On the Value of Overseas Bases
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
- P-2109 Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium
- P-2212 Load Moving with Super-seismic Speed over a Layered Elastic Solid
- P-2263 A Case for Survival Deep Underground

CIVIL DEFENSE

- R-322-RC Report on a Study of Non-military Defense
- RM-2206-RC Some Specific Suggestions for Achieving Early Non-military Defense Capabilities and Initiating Long-range Programs
- RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- RM-2844-PR Postattack Damage Assessment: A Conceptual Analysis
- P-1497-RC Major Implications of a Current Nonmilitary Defense Study
- P-1683-RC A Discussion of *Report on a Study of Nonmilitary Defense*
- P-1719 Civil Defense for Williamstown?
- P-1927 Lecture on Civil Defense
- P-2009 Time and Civil Defense
- P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint

DETECTION

- RM-1217 Probability of Detection for Fluctuating Targets
- RM-1238 Detection Range of an Active Radar Seeker
- RM-2169 An Identification System for Use as an Aid to Raid Detection and Air Traffic Control
- P-1697 A Broad Look at the Performance of Infrared Detectors
- P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1976 The Far-field Back-scattering from a Concave Corner of a Body of Revolution
- P-1995 Reliable Digital Communications Systems Using Unreliable Network Repeater Nodes
- P-2030 On Style in Research and Development
- P-2046 On the Problem of Ballistic Missile Defense
- P-2432 Hiders and Finders: An Approach to Inspection and Evasion Technology
- T-105 The Interception Problems of Intercontinental Missiles—

ENEMY OFFENSIVE CAPABILITIES

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-2474 A Stochastic Force Survival Model
- P-1675 Why Go Deep Underground?
- P-2046 On the Problem of Ballistic Missile Defense
- P-2263 A Case for Survival Deep Underground
- T-40 Soviet Long-range Bomber Bases Near the North Pole

INTERCEPTION AND INTERCEPTOR CONTROL

- RM-316 Maneuvering and Scanning Barriers for All-weather Interceptions: A Graphical Method
- RM-890 The Systems Research Laboratory and Its Program
- RM-922 Observations and Comments on the Organization Studies of the Systems Research Laboratory
- RM-1916 Data for Testing a Model of Organizational Behavior
- P-2046 On the Problem of Ballistic Missile Defense
- T-105 The Interception Problems of Intercontinental Missiles

MATHEMATICAL MODELS

- RM-123 An Integral Arising in Vulnerability Studies
- RM-189 Note on Some Historic Principles of Target Selection
- RM-252 Composite Targets: n Identical Elements
- RM-318 A Preliminary Model for an Air Battle
- RM-319 Local Defense of Targets of Equal Value
- RM-320 Local Defense of Targets of Equal Value: Extension of Results
- RM-329 Local Defense of Targets of Equal Value: Completion of Results
- RM-359 n Targets of Differing Vulnerability with Attack Stronger than Defense
- RM-677 The Determination of Decision Regions for a Simplified Two-plane Bombing Model
- RM-684 Decision Functions for Bombing Models
- RM-914 Algorithm for Computing Optimum Distribution of Local Defense

DEFENSE STUDIES—continued

MATHEMATICAL MODELS—continued

- RM-1751 On the Computational Solution of Dynamic-programming Processes—VII: Radar Nets
- RM-1809 Vulnerability and Recuperation of a Regional Economy: A Study of the Impact of a Hypothetical Atomic Attack on New England
- RM-2474 A Stochastic Force Survival Model
- RM-2491 A Parametric Study of Surface-to-air Missiles versus Low-altitude Targets
 - P-1678 An Approximating Algorithm for an Optimum Aim-points Problem
 - P-2264-1 Some Suggested Techniques for Data System Development

MISCELLANEOUS

- R-212 Air War and Emotional Stress: Psychological Studies of Bombing and Civilian Defense
- RM-28 Active Defense of the United States against Air Attack
- RM-673 Flight Test of ASR-1 Radar at Low Altitudes
- RM-727 The Use of Experts for the Estimation of Bombing Requirements: A Project Delphi Experiment
- RM-1029 Transmission of Pulses over Voice-quality Telephone Lines
- RM-1377 The Influence of a Variable Atmosphere on the Blast from a High Burst
- RM-1654 The Influence of an Aggressor's Attack Effectiveness upon the Characteristics Desired for a Defender's Air Force
 - P-497 Atomic Weapons and Ground Combat: Search for Organization and Doctrine
 - P-669 The Influence of Mass Destruction Weapons on Strategy
 - P-804-AD System Training Program
- P-889 Comments on Warfare in the Next Ten to Twenty Years
 - P-1660 Is Defense Spending Wasteful?
 - P-1684 A Note on the Computation of Single-sideband Peak Power
 - P-1748 What Interdependence for NATO?
- P-1850 Is Deterrence Enough or Should We Be Prepared To Fight a General War in the 1960's?
 - P-1888-RC The Nature and Feasibility of War and Deterrence
- P-1917 Psychological Inspection
 - P-2046 On the Problem of Ballistic Missile Defense
 - P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options

PASSIVE DEFENSE

- R-322-RC Report on a Study of Non-military Defense
- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
 - RM-1985 A Vulnerability Model for Weapon Sites with Interdependent Elements
- RM-2206-RC Some Specific Suggestions for Achieving Early Non-military Defense Capabilities and Initiating Long-range Programs
- RM-2617 Geological Covering Materials for Deep Underground Installations
 - RM-2627-PR Cost of a Hardened, Nationwide Buried Cable Network
- P-215 Efficiency Aspects of Dispersal of Population and Industry
- P-301 Are We Sure about Dispersal?
 - P-438 The Vulnerability of the United States to Enemy Attack: Elements of an Unclassified Research Program in the Social Sciences
 - P-517 Compensation for War Damage: An Economic View
 - P-519 War Damage Insurance
 - P-548 Is Dispersal Good Defense?
 - P-1384 A Vulnerability Model for Weapon Sites with Interdependent Elements
 - P-1657 Protection of Communications and Electronic Systems
 - P-1675 Why Go Deep Underground?

- P-1683-RC A Discussion of *Report on a Study of Non-military Defense*
- P-1719 Civil Defense for Williamstown?
- P-1927 Lecture on Civil Defense
- P-2009 Time and Civil Defense
- P-2084-RC No Highway to High Purpose
- P-2109 Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium
- P-2212 Load Moving with Super-seismic Speed over a Layered Elastic Solid
- P-2255 How Arms Controls Would Affect the National Security Budget
- P-2263 A Case for Survival Deep Underground
- P-2351 American Attitudes toward War: Their Influence on Arms Control Proposals

TARGETS

- RM-189 Note on Some Historic Principles of Target Selection
- RM-252 Composite Targets: *n* Identical Elements
- RM-2715 Structures under Repeated Blast Loadings
- P-438 The Vulnerability of the United States to Enemy Attack: Elements of an Unclassified Research Program in the Social Sciences
- P-2263 A Case for Survival Deep Underground
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options

ECONOMICS—See also Cost Analysis Studies, Logistics, and Systems Analysis

ECONOMIC ASPECTS OF MILITARY PLANNING

- R-224 Economic Replacement Policy
- R-287 Weapon-system Cost Methodology
- R-333 Military Research and Development Policies
- R-346 The Economics of Defense in the Nuclear Age
- RM-37 The Concept of Military Worth
- RM-614 Note on the Formulation of the Study of Logistics
- RM-709 Report of a Seminar on Organization Science
- RM-1926-RC NATO Deterrent vs. Shield
- RM-2153 Economic Replacement Policy
- RM-2482 The Economics of Parallel R and D Efforts: A Sequential-decision Analysis
- RM-2695 System and Total Force Cost Analysis
- RM-2858-PR The Nature of Research Goals: Some Necessary Definitions
- P-105 Planning Defense Production
- P-200 Taxation and Incentive in Mobilization
- P-301 Are We Sure About Dispersal?
- P-326 Suboptimization in Operations Problems
- P-386 Suboptimization Criteria and Operations Research
- P-462 Some Economic Aspects of Fissionable Material
- P-470 Notes on the Optimal Choice of Weapons
- P-517 Compensation for War Damage: An Economic View
- P-519 War Damage Insurance
- P-530 Which Program Do We Mean in "Program Budgeting"?
- P-548 Is Dispersal Good Defense?
- P-694 The Role of Management Tools in Making Military Decisions
- P-922 Is "Dual" Preparedness More Expensive?
- P-1030 Operations Research: A New Science?
- P-1051 The Economics of Navy Pay
- P-1054 Application of Operations Research to Development Decisions
- P-1080-RC Economic Problems of Alliance
- P-1100 The Mathematics of Military Pay
- P-1103-RC NATO Deterrent vs. Shield
- P-1159 Economic Problems in Air Force Logistics

ECONOMICS—continued

ECONOMIC ASPECTS OF MILITARY PLANNING—continued

- P-1186 Supply and Demand and Military Pay
- P-1195 Economics of a Dual Capability
- P-1197 Federal Spending for National Security
- P-1240 Lead-time in Modern Weapons
- P-1242-RC On NATO Pooling
- P-1250 Economics and Military Operations Research
- P-1267 What's Wrong with Military R and D?
- P-1297 The Character of Research and Development in a Competitive Economy
- P-1462 Economics of Defense Procurement and Small Business
- P-1531 Some Complexities in Military Planning
- P-1566 The Place of Limited War in NATO Strategy
- P-1571 Some Political and Economic Aspects of Overseas Missile Bases
- P-1574 Surprise Attack and Disarmament
- P-1582 The Economic Analysis of Defense: Choice without Markets
- P-1602 Evaluating Alternative Expenditure Programs
- P-1604 The Economics of Invention: A Survey of the Literature
- P-1640 Defense Planning and Organization
- P-1660 Is Defense Spending Wasteful?
- P-1743 Competition and Complementarity between Defense and Development: A Preliminary Approach
- P-1748 What Interdependence for NATO?
- P-1758 A Further Comment on Economics and Operations Research
- P-1774 The Economics of Parallel R and D Efforts
- P-1776 National Security Policy as a Field for Economics Research
- P-1779 What Do We Mean by "Research and Development"?
- P-1787 The Support of Future Weapons
- P-1803 The Federal Budget as an Indicator of Government Intentions and the Implications of Intentions
- P-1821 Predictability of the Costs, Time, and Success of Development
- P-1833 The Simple Mathematics of Maximization
- P-1883 Comments on Some Aspects of Corporate Planning in the Defense Industry
- P-1901-RC Strategy and Organization in a System Development Project
- P-1916 The Decisionmaking Problem in Development
- P-1959 Uncertainties in Operations Research
- P-1975 Economic Aspects of Developing and Orbiting a Space Station
- P-2006 Economic Planning and the Military Electronics Industry
- P-2021 Weapon System Cost Sensitivity Analysis as an Aid in Determining Economic Resource Impact
- P-2135 Identifying R&D: A Management Problem
- P-2140 Mechanics of Some Limited Disarmament Measures: A Simple Economic Treatment
- P-2147 The Nature and Function of Military R&D
- P-2174 On the Uses of Economics: Theory, Policy, and Values
- P-2179-RC The Uses of Economics
- P-2222 New Tools for Planners and Programmers
- P-2336 The Role of the Military Comptroller in Defense Management
- P-2383 Anyone for the Moon?

ECONOMIC MODELS

- R-258-RC A Brief Survey of the Technology and Economics of Water Supply
- R-318 A Time Series Analysis of Interindustry Demands
- RM-46 Systems of Linear Production Function (Cowles Commission Discussion Papers, Economics, No. 215)
- RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan
- RM-954 On Predicting a Combination of Outputs and Final Demands by Input-Output
- RM-1488 Studies in the Economics of Transportation

- RM-1757 A Linear Programming Model of the U.S. Petroleum Refining Industry
- RM-1801 A Linear Programming Model of the Gaseous Diffusion Isotope-separation Process
- RM-2134 On the Computational Solution of Dynamic-programming Processes—XV: An Industrial Replacement Process
- RM-2205 A Spatial Model of U.S. Petroleum Refining
- RM-2245 On the Computational Solution of Dynamic-programming Processes—XVI: Reliability of Multicomponent Devices
- RM-2297 A Dynamic, Single-item, Multi-echelon Inventory Model
- RM-2425 Computing Tetraethyl-lead Requirements in the Linear-programming Format: Notes on Linear Programming and Extensions—Part 52
 - P-108 An Airframe Production Function
 - P-189 Optimal Inventory Policy
 - P-208 Specific Industry Output Projections
- P-239 Comparisons of Input-Output and Alternative Projections, 1929–1939
- P-243 Comments on H. J. Barnett's *Specific Industry Output Projections*
- P-251 An Econometric Model of Interindustry Material Flows
 - P-290 A Continuous Model of Transportation
- P-308 Activity Analysis and the Prediction of Traffic Flows
- P-309 A Survey of Input-Output Research
- P-310 Numerical Representations of Technological Change
- P-335 Activity Analysis of Technological Structures in Production: An Example
 - P-352 Activity Analysis and Its Applications
- P-437 The Determination of Traffic in a Road Network: An Economic Approach
- P-533 Air Cargo Transport Scheduling: An Illustrative Block Triangular System
- P-563 A Linear Programming Model of the U.S. Petroleum Refining Industry
 - P-689-RC Criteria for the Selection of Water-resource Projects
- P-727 The Allocation of Aircraft to Routes: An Example of Linear Programming under Uncertain Demand
- P-942 The Combination of Time Series and Cross-section Data in Interindustry Flow Analysis
 - P-1034-RC Feather River Water for Southern California
 - P-1099 Regional Science Techniques Applicable to Regional Planning
- P-1227 Dynamic-programming Approach to Optimal Inventory Processes with Delay in Delivery
 - P-1282 On the Computational Solution of Dynamic Programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- P-1347 A Marginal Cost Function for Highway Construction and Operation
- P-1363 Aggregation of Utility Functions
- P-1392 The Solutions of a Symmetric Market Game
- P-1413 Top Management Decision and Simulation Processes
- P-1478 A Mathematical Study of Arbitrage
- P-1502 A Machine-job Scheduling Model
- P-1526 Sequencing n Jobs on Two Machines with Arbitrary Time Lags: Alternate Proof and Discussion of General Case
 - P-1545 Computing Tetraethyl Lead Requirements in the Linear Programming Format
- P-1552 Random Variations and Sampling Models in Production Economics
- P-1555 The Simulation of a Large-scale Military Activity
 - P-1623 Reliability, Quality Control, and Simulation
- P-1634 Integration of Modelling and Simulation in Organizational Studies
- P-1689 The Use of Numerical Simulation in the Development of Inventory Policy
- P-1808 Simulation Techniques
- P-1899 The Separation of Uranium Isotopes by Gaseous Diffusion: A Linear-programming Model
 - P-1904 Economic Development and the Employment of Resources
 - P-1971 A Note on Stability, and the Behavior Assumptions of Harrod-type Models
- P-2057-RC Water Supply for Southern California: Rationalization or Expansion?
- P-2136-RC The RAND Study of Water Supply
 - P-2149-1 Investment, Innovation, and Growth
- P-2183 The Crude Analysis of Strategic Choices

ECONOMICS—continued

ECONOMIC MODELS—continued

- P-2194-RC Another Small Problem in the Analysis of Growth
- P-2296 Simulation and Tax Analysis: A Research Proposal
- P-2342-1 On Regional Development and Dynamic Models
- P-2468-1 A Macro Investment Model for Manufacturing

ECONOMIC THEORY: ECONOMETRICS

- R-193 Activity Analysis of Production and Allocation (Proceedings of a Conference)
- R-210 A Study of Project scoop Linear Programming
- R-318 A Time Series Analysis of Interindustry Demands
- RM-46 Systems of Linear Production Function (Cowles Commission Discussion Papers, Economics, No. 215)
- RM-47 Remarks on Reduction and Aggregation
- RM-114 Note on Optimal Decisions in Differential Equation Processes
- RM-179 Market Mechanisms and Maximization—III: Dynamics and Linear Programming
- RM-210 The Le Chatelier Principle in Linear Programming
- RM-407 A Note on the Hitchcock-Koopmans Problem
- RM-540 Notes on the Dynamic Approach to Saddle Points and Extremum Points: Gradient Methods and the Equations of Classical Mechanics
- RM-674 Note on the Problem of Aggregation
- RM-676 LaGrange Multipliers Revisited (A Contribution to Nonlinear Programming)
- RM-690 An Inventory Problem: The Bankruptcy Question
- RM-954 On Predicting a Combination of Outputs and Final Demands by Input-Output
- RM-1488 Studies in the Economics of Transportation
- RM-1746 On the Computational Solution of Dynamic-programming Processes—II: On a Cargo-loading Problem
- RM-1833 Notes on Linear Programming—Part XXXVI: The Allocation of Aircraft to Routes—An Example of Linear Programming under Uncertain Demand
- RM-1861 An Industrial-location Planning Problem
- RM-1889 On the Computational Solution of Dynamic-programming Processes—X: The Fly-away-kit Problem
- RM-1901 On the Computational Solution of Dynamic-programming Processes—IX: A Multi-stage Logistic-procurement Model
- RM-2297 A Dynamic, Single-item, Multi-echelon Inventory Model
- RAOP-37 Bayes and Minimax Solutions of Sequential Decision Problems
- P-117 International Commodity Equilibrium: Solution by Electric Analogue
- P-189 Optimal Inventory Policy
- P-213 On the Hitchcock Distribution Problem
- P-223 A Gradient Method for Approximating Saddle Points and Constrained Maxima
- P-234 On the Application of Servomechanism Theory in the Study of Production Control: A Study in the Theory of Organization
- P-251 An Econometric Model of Interindustry Material Flows
- P-290 A Continuous Model of Transportation
- P-298 Comment on Solow's "Structure of Linear Models"
- P-303 A Social Equilibrium Existence Theorem
- P-309 A Survey of Input-Output Research
- P-352 Activity Analysis and Its Applications
- △ P-461 Interrelations between Linear Programming and Game Theory
- P-609 A Linear Programming Solution to Dynamic Leontief Type Models
- P-649 An Activity Analysis Approach to Location Theory
- P-685 Linear Programming and Economic Theory
- P-706 Reduction of Constrained Maxima to Saddle-point Problems
- P-941 A Feasibility Algorithm for One-way Substitution in Process Analysis
- P-942 The Combination of Time Series and Cross-section Data in Interindustry Flow Analysis
- P-989 Sequential Production Planning over Time at Minimum Cost
- P-1039 A Generalized Equipment Replacement Study

- P-1045 A Note on an Industrial Replacement Process
- P-1056 On the Construction of a Multi-stage, Multi-person Business Game
- P-1066 A Markovian Decision Process
- P-1083 Dynamic Programming Solution of Allocation Problems
- P-1156 General Equilibrium for Linear Models
- P-1243 Some Methodological Notes on the Deflation of Construction
- P-1488 The Meaning and Validity of Inflation-induced Business Profits Resulting from a Lag of Wages behind Prices
- P-1567 Money and the Interest Rate in a Neoclassical World
- P-1587 Centralization and Decentralization in Economic Organizations
- P-1847 Quasi-concave Programming
- P-1971 A Note on Stability, and the Behavior Assumptions of Harrod-type Models
- P-2376 Note on Program Uncertainty in Dynamic Inventory Problem
- P-2384 A Boundedness Property of the Closed Linear Model of Production
- P-2463 Aggregation of Magnitude Judgments
- T-76 *The Causes of Systematic Error in the Cost Estimates of Public Works* by R. Giguët and G. Morlat (Paris, 1952)

ECONOMIC THEORY: GENERAL

- R-224 Economic Replacement Policy
- R-258-RC A Brief Survey of the Technology and Economics of Water Supply
- R-346 The Economics of Defense in the Nuclear Age
- RM-175 The Pricing System in Peacetime
- RM-373 On Mandelbaum's Study of the Industrialization of Backward Areas
- RM-488 The Law of Value and Soviet Economic Planning
- RM-1325 The Compressibility of Organizations and Economic Systems
- RM-1342 Proposal for the Development of a Theory of Economic Growth for a Soviet-type Economy
- RM-1434-RC Bargaining: The Hidden Hand in Government
- RM-2096 A Selected Bibliography on Economic Development and Foreign Aid
- RM-2146 The Economics of Invention: A Survey of the Literature
- RM-2153 Economic Replacement Policy
- RM-2190-RC An Economic Analysis of the Market for Scientists and Engineers
- RM-2858-PR The Nature of Research Goals: Some Necessary Definitions
- RAOP-41 The Possibility of a Universal Social Welfare Function
- P-49 The Determination of Many-commodity Preference Scales by Two-commodity Comparisons
- P-69 Market Mechanisms and Maximization
- P-116 Efficient Allocation of Resources
- P-177 The Choice among Investment Alternatives in Soviet Economic Theory
- P-200 Taxation and Incentive in Mobilization
- P-204 A Formal Theory of the Employment Relationship
- P-206 The Coefficient of Resource Utilization
- P-292 Abstract: Proofs of the Law of Diminishing Returns
- P-308 Activity Analysis and the Prediction of Traffic Flows
- P-310 Numerical Representations of Technological Change
- P-325 Depreciation, Replacement, and Growth
- P-326 Suboptimization in Operations Problems
- P-357 A Classical Tax-subsidy Problem
- P-365 A Behavioral Model of Rational Choice
- P-386 Suboptimization Criteria and Operations Research
- P-406 The Exchange between Quantity and Quality
- P-437 The Determination of Traffic in a Road Network: An Economic Approach
- P-462 Some Economic Aspects of Fissionable Material
- P-470 Notes on the Optimal Choice of Weapons
- P-503 Petroleum Refinery Operations Scheduling: Chapter VII—The Economist and the Operations Scheduler
- P-685 Linear Programming and Economic Theory

ECONOMICS—continued

ECONOMIC THEORY: GENERAL—continued

- P-689-RC Criteria for the Selection of Water-resource Projects
- P-808 Economic Development and the Rate of Interest under Dictatorial Conditions
- P-999-RC Operations Research and Government Budgets
- P-1034-RC Feather River Water for Southern California
- P-1136 Factor Productivity and Economic Growth
- P-1154 Do Disparities between Real and Money Prices Modify Traditional Arguments for Freer Trade?
- P-1158 An Isoquant Approach to Investment Decision Problems
- P-1169-RC Does Efficient Peak-load Pricing Involve Discrimination?
- P-1180-RC Criteria of Efficiency in Government Expenditures
- P-1255 Factors Associated with Income Variability
- P-1275 What the Factory Worker Knows about His Factory
- P-1288 The Simple Economics of Basic Scientific Research: A Theoretical Analysis
- P-1297 The Character of Research and Development in a Competitive Economy
- P-1308 The Theory of Hedging and Speculation in Commodity Futures
- P-1364-RC Price-Quantity Adjustments in Multiple Markets with Rising Demands
- P-1365-RC Dynamic Shortages and Price Rises: The Engineer-Scientist Case
- P-1398 Comments on Wiles' *Rationality, the Market, Decentralization, and the Territorial Principle*
- P-1449 Costs and Outputs
- P-1480 A Note on the Relationship of Saving to the Rate of Interest, Real Income, and Expected Future Prices
- P-1491 Prospectus for a Reorientation of Game Theory
- P-1516 Single Ownership of a Superior Resource: The Road Case Again Re-examined
- P-1537 Growth Models and the Escape from the Low-level Equilibrium Trap: The Case of Japan
- P-1583 Gains from Trade, Materials Supplies, and Economic Development
- P-1587 Centralization and Decentralization in Economic Organizations
- P-1602 Evaluating Alternative Expenditure Programs
- P-1687 Uncertainty, Prediction, and Competitive Equilibrium
- P-1692 The Content of Economics
- P-1744 Government Efficiency and the Military "Buyer-Seller" Device
- P-1789 Economic Consequences of Substantial Changes in the Method of Taxing Capital Gains and Losses
- P-1796 The Normative Interest Rate
- P-1833 The Simple Mathematics of Maximization
- P-1872 Taxation and the Demand for Alcoholic Beverages
- P-1904 Economic Development and the Employment of Resources
- P-1905 Differences between the Personal Demand for Money and the Business Demand for Money
- P-1959 Uncertainties in Operations Research
- P-1982 Economic Development, Research and Development, Policymaking: Some Converging Views
- P-2057-RC Water Supply for Southern California: Rationalization or Expansion?
- P-2088-2 Is Investment Really Unimportant?
- P-2089-3 Research and Economic Growth: The Role of Public Policy
- P-2090-2 A Disaggregated View of Technical Change
- P-2103 Some Observations on Capital Longevity
- P-2118 Capital Intensity as a Mitigation of Inferior Labor: A General Theorem
- P-2119 On Measuring Productive Potential and Relative Efficiency
- P-2125 On Convexity, Efficiency, and Markets
- P-2136-RC The RAND Study of Water Supply
- P-2140 Mechanics of Some Limited Disarmament Measures: A Simple Economic Treatment
- P-2143 Risk, the Discount Rate, and Investment Decisions

- P-2149-1 Investment, Innovation, and Growth
- P-2155 What Can Managerial Economics Contribute to Economic Theory?
- P-2167 Economic Natural Selection and the Theory of the Firm
- P-2173 Risk, Ambiguity, and the Savage Axioms
- P-2174 On the Uses of Economics: Theory, Policy, and Values
- P-2179-RC The Uses of Economics
- P-2194-RC Another Small Problem in the Analysis of Growth
- P-2203 The Economics of Compensating Balances
- P-2217 Economic Aid Reconsidered
- P-2219 On Capital Theory and Development Planning
- P-2226 Production Functions and Capital Depreciation
- P-2252 Decision Making for Public Investment: Discussion
- P-2296 Simulation and Tax Analysis: A Research Proposal
- P-2316 Some Economics of Property
- P-2410 An Exposition of the Equilibrium of the Firm: Symmetry of the Product and Factor Analyses
- P-2448 The Firm's Cost Function: A Successful Reconstruction?
- P-2488-1 Behavior of the Firm Subject to External Regulatory Constraint
- P-2510 Determinants of Productivity Change in United States Manufacturing
- P-2533 Urban Economic Accounts and Research: A Comment
- P-2540 Some Investment Criteria for Underdeveloped Areas
- T-25 Undetermined Wage Problems

ECONOMIC WAR AND RECUPERATION POTENTIAL

- RA-15079 Economic Survey: The Potential Production of Anhydrous Hydrazine, Propellant for Supersonic Vehicles
- R-121 Economic Survey: The Potential Availability of Ammonia, Nitric Acid, and Nitrogen Tetroxide, Propellants for Supersonic Vehicles
- R-124 Economic Survey: The Potential Production of Liquid Fluorine, Chlorine Trifluoride, and Other Fluorine Compounds, Propellants for Supersonic Vehicles
- R-253 Soviet National Income and Product, 1940 through 1948
- R-255 Soviet National Income and Product in 1928
- R-257 Labor Productivity in Soviet and American Industry
- R-367-PR The Real National Income of Soviet Russia since 1928
- RM-104 The Economic Strength of the Soviet Union
- RM-299 The Economic Sinews of Modern War: Physical Limitations on War Production
- RM-346 The German Munitions Production Index: World War II
- RM-367 The Economic War Potential of the United States and the Soviet Union
- RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan
- RM-1263 The Geographic Distribution of Metal-working Equipment
- RM-1325 The Compressibility of Organizations and Economic Systems
- RM-1809 Vulnerability and Recuperation of a Regional Economy: A Study of the Impact of a Hypothetical Atomic Attack on New England
- RM-2544 Soviet National Income and Product, 1928-48: Revised Data
- RM-2844-PR Postattack Damage Assessment: A Conceptual Analysis
- RM-2952-PR Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
- P-105 Planning Defense Production
- P-182 The Economic War Potential of the USSR
- P-273 The What and the How Are Both Essential to Munitions Production
- P-420 The Supply of Female Labor in World War II
- P-674 Some Thoughts on the Social Structure after a Bombing Disaster
- P-1025 Klaus Knorr on War Potential: A Brief Review
- P-1323 Controlling Consumers during Future Wars and Their Aftermaths
- P-1377 Strategy and Economics: A Soviet View
- P-1497-RC Major Implications of a Current Nonmilitary Defense Study
- P-1881 Comparisons of United States and USSR National Output: Some Rules of the Game
- P-2089-3 Research and Economic Growth: The Role of Public Policy

ECONOMICS—continued

ECONOMIC WAR AND RECUPERATION POTENTIAL—continued

- P-2093 The Importance of Individual Industries for Defense Planning
- P-2119 On Measuring Productive Potential and Relative Efficiency
- P-2124 The Importance of Individual Industries for Defense Planning: Supplemental Data
- P-2133-1 Consumption Levels in the Soviet Union and the United States
- P-2148-1 Soviet National Income
- P-2274-1 Economic Development and Postwar Recuporation: A Comparison of Industrial Priorities
- P-2286 Economic Growth and Soviet-American Rivalry
- P-2291-1 Defense and Development in Less Developed Countries
- P-2416 Economic Recovery from the Effects of Thermonuclear War

FOREIGN ECONOMICS STUDIES (EXCLUDING S.U.)

- RM-373 On Mandelbaum's Study of the Industrialization of Backward Areas
- RM-1506-RC The Politics of German Business
- RM-1778-RC Economic Development and Mutual Security: Some Problems of U.S. Foreign Assistance Programs in Southeast Asia
- RM-1821 Electric Power Development in Mainland China: Prewar and Postwar
- RM-2096 A Selected Bibliography on Economic Development and Foreign Aid
- RM-2175 Agriculture in Communist Germany
- RM-2185 Middle East Crises and World Petroleum Movements
- RM-2207 Government Acquisition of Agricultural Output in Mainland China, 1953-56
- RM-2385 Survey of Energy and Oil Demand Projections for Western Europe
- RM-2414 Dependence of East Germany on Western Imports
- RM-2768 The Indonesian Eight-year Over-all Development Plan
- P-972-RC Soviet Economic Aid in Southeast Asia: Threat or Windfall?
- P-993-RC Japan's Economic Future in Asia
- P-1061-RC Comments Prepared for Annual Meeting of the Association for Asian Studies, Panel Discussion of Economic Development in South Asia, Sheraton-Plaza, Boston, April 3, 1957
- P-1080-RC Economic Problems of Alliance
- P-1136 Factor Productivity and Economic Growth
- P-1170 Israel's National Expenditure: Summary of Results
- P-1298 Economic Prospects for Communist China
- P-1340-RC Economic Research on Southeast Asia in the United States: Status and Needs
- P-1411 The Failures of the World Bank Missions
- P-1421 Middle East Crises and World Petroleum Movements
- P-1439 Social Charges in the EEC Countries: Some Economic Aspects
- P-1445 Review of OEEC, *Some Aspects of the European Energy Problem*, and OEEC, *Europe's Growing Needs of Energy: How Can They Be Met?*
- P-1461 A Review of OEEC, *Oil: The Outlook for Europe*, and OEEC, *Europe's Need for Oil: Implications and Lessons of the Suez Crisis*
- P-1466 A Review of Energy Forecasts in Western Europe
- P-1522 The Economic Development of Morocco
- P-1537 Growth Models and the Escape from the Low-level Equilibrium Trap: The Case of Japan
- P-1578 An Economic Development of Strategic Significance in Communist China
- P-1583 Gains from Trade, Materials Supplies, and Economic Development
- P-1590 Structural Changes in the Economy of the Chinese Mainland, 1933 to 1952-1957
- P-1616 The Federation of Rhodesia and Nyasaland: A Case Study in Economic Development
- P-1649 The Gains to India from Population Control: Some Money Measures and Incentive Schemes
- P-1668 The Export-Import Bank and Development Lending
- P-1682 Review of United Nations, Department of Economic Affairs, *The Development of Manufacturing Industry in Egypt, Israel, and Turkey*
- P-1721 Preliminary Thoughts about India's Third Five-Year Plan

- P-1739 Review of Choh-ming Li's *Economic Development of Communist China* (Berkeley, 1959)
- P-1793 A New Book on East German Trade
- P-1871 Theory and Policy in the French Nationalized Industries
- P-1943 Communist Economic Subversion: A Reappraisal
- P-2031-RC The Financing of Public Investment in Communist China
- P-2087 Sino-Soviet Economic Relations in Recent Years
- P-2161 The Role of the Chinese in Lao Society
- P-2176 The Public and Private Sectors and Investment in Israel
- P-2208 The Trade Agreements of Communist China
- P-2209 Energy Policy and Security of Energy Supply in Western Europe
- P-2217 Economic Aid Reconsidered
- P-2274-1 Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
- P-2287 Economic Growth and Foreign Aid: A Proposal Concerning the Export of Industrial Plants
- P-2288 On Aspects of Korea's Five-year Development Plan
- P-2291-1 Defense and Development in Less Developed Countries
- P-2313 The Indonesian Eight-year Over-all Development Plan
- P-2388 The European Coal and Steel Community
- P-2469 Studies in Economic Planning: A Trip Report
- P-2524 A Note on the National Accounts of Algeria, 1950-1959 and 1964
- T-136 West German Attitudes toward Economic Aid for Underdeveloped Areas

MISCELLANEOUS

- RM-821-6 Selected List of Unclassified Publications of the Economics Division of The RAND Corporation
- RM-1934-RC A Case Study in the Measurement of Government Output
- RM-2490-1 Thermoelectric Powerplants Utilizing Contained Nuclear Explosions
- RM-2800-PR Economics Department Publications, 1948-1961: An Author Index of the Open Literature, with Abstracts
- P-1465 A New Look at Experience Rating
- P-1796 The Normative Interest Rate
- P-2084-RC No Highway to High Purpose
- P-2089-3 Research and Economic Growth: The Role of Public Policy
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2314 Aspects of Synchronous Communication Satellites
- P-2396 Economic Aspects of Communication Satellite Systems
- P-2469 Studies in Economic Planning: A Trip Report
- P-2486 Air Transport and Economic Development: Some Comments on Foreign Aid Programs

PROCESS ANALYSIS AND INDUSTRY STUDIES

- RM-563 Estimating Output from Floor Space: Feasibility
- RM-1085 Process Analysis of the Metal-working Industries
- RM-1091 A Review of the Steel Industry of the United States
- △ RM-1254 The Nature and Applications of Process Analysis
- RM-1263 The Geographic Distribution of Metal-working Equipment
- RM-1512 An Analysis of Machine Tool Substitution Possibilities
- RM-1549 A Compendium of Pressworking Operations
- RM-1757 A Linear Programming Model of the U.S. Petroleum Refining Industry
- RM-1801 A Linear Programming Model of the Gaseous Diffusion Isotope-separation Process
- RM-1976 Notes on Linear Programming—Part XLIII: A Feasibility Algorithm for One-way Substitution in Process Analysis
- RM-2146 The Economics of Invention: A Survey of the Literature
- RM-2205 A Spatial Model of U.S. Petroleum Refining
- RM-2385 Survey of Energy and Oil Demand Projections for Western Europe

ECONOMICS—continued

PROCESS ANALYSIS AND INDUSTRY STUDIES—continued

- RM-2952-PR Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
 - P-108 An Airframe Production Function
- P-383 Concave Programming for Gasoline Blends
- P-448 The Allocation of Switching Work in a System of Classification Yards
 - P-479 A Motor Gasoline Blending Problem
- P-481 Petroleum Refinery Operations Scheduling—Chapter II: Conventional Methods of Refinery Economic Analysis
- P-484 Petroleum Refinery Operations Scheduling—Chapter III: A Crude Oil Allocation Problem
- P-487 Petroleum Refinery Operations Scheduling—Chapter V: A Gasoline Blending Problem
- P-489 Petroleum Refinery Operations Scheduling—Chapter IV: A Naphtha Reforming Problem
- P-493 Petroleum Refinery Operations Scheduling—Chapter VI: Cracking, Recycling, and Blending—An Integrated Refinery Problem
- P-502 Petroleum Refinery Operations Scheduling—Chapter I: Introduction
- P-503 Petroleum Refinery Operations Scheduling—Chapter VII: The Economist and the Operations Scheduler
- P-547 The Nature and Applications of Process Analysis
- P-563 A Linear Programming Model of the U.S. Petroleum Refining Industry
- P-600 Industry-wide, Multi-industry, and Economy-wide Process Analysis
- P-941 A Feasibility Algorithm for One-way Substitution in Process Analysis
 - P-1191 Dynamic Problems in the Theory of the Firm
 - P-1370 Manufacturers' Inventory Cycles and Monetary Policy
 - P-1382 Book Review: Bruce Netschert, *The Future Supply of Oil and Gas*
 - P-1445 Review of OEEC, *Some Aspects of the European Energy Problem*, and OEEC, *Europe's Growing Needs of Energy: How Can They Be Met?*
 - P-1461 A Review of OEEC, *Oil: The Outlook for Europe*, and OEEC, *Europe's Need for Oil: Implications and Lessons of the Suez Crisis*
 - P-1466 A Review of Energy Forecasts in Western Europe
- P-1504 Female Labor Force Participation and Economic Development
- P-1604 The Economics of Invention: A Survey of the Literature
- P-1847 Quasi-concave Programming
 - P-1854-RC The Link between Science and Invention: The Case of the Transistor
- P-1856-RC Economic Welfare and the Allocation of Resources for Invention
- P-1899 The Separation of Uranium Isotopes by Gaseous Diffusion: A Linear-programming Model
- P-2006 Economic Planning and the Military Electronics Industry
- P-2065 A Model Punched Card System for Production Control
- P-2073-RC Introduction to the UNBER-SSRC Conference Volume on Inventive Activity
- P-2077 Southern California's Economy in the Sixties
- P-2088-2 Is Investment Really Unimportant?
- P-2090-2 A Disaggregated View of Technical Change
- P-2093 The Importance of Individual Industries for Defense Planning
- P-2103 Some Observations on Capital Longevity
- P-2124 The Importance of Individual Industries for Defense Planning: Supplemental Data
- P-2143 Risk, the Discount Rate, and Investment Decisions
- P-2155 What Can Managerial Economics Contribute to Economic Theory?
- P-2167 Economic Natural Selection and the Theory of the Firm
- P-2209 Energy Policy and Security of Energy Supply in Western Europe
- P-2274-1 Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
- P-2286 Economic Growth and Soviet-American Rivalry
- P-2287 Economic Growth and Foreign Aid: Proposal Concerning Export of Industrial Plants
- P-2295 An Introduction to Automated Production Control System

- P-2388 The European Coal and Steel Community
- P-2410 An Exposition of the Equilibrium of the Firm: Symmetry of the Product and Factor Analyses
- P-2448 The Firm's Cost Function: A Successful Reconstruction?
- P-2468-1 A Macro Investment Model for Manufacturing
- P-2488-1 Behavior of the Firm Subject to External Regulatory Constraint
- P-2497 Automatic Data-processing for Production Control
- P-2510 Determinants of Productivity Change in United States Manufacturing
- P-2568 Technological Change and Local Economy

SOVIET AGRICULTURE

- RM-336 The Economics of Soviet Agriculture
- RM-1173 The New Soviet Plans for Agriculture and Consumption
- RM-1178 The New Soviet Agricultural Decrees (September Plenum, 1953)
- RM-1248 The Agricultural Labor Force and Population of the USSR: 1926-41
- RM-1250 Statistics of Soviet Agriculture
- RM-1552 Soviet Agriculture since the September, 1953, Reforms
- RM-1561 A Study of the Growth Potential of Agriculture of the USSR
- RM-1733 Collective Farm Investment in the USSR
- RM-1930 Soviet Agricultural Marketings and Prices, 1928-1954
- RM-2326 Soviet Statistics of Meat and Milk Output: A Note on Their Comparability over Time
- P-109 Productivity and Welfare in Soviet Agriculture
- P-278 Soviet Agricultural Prospects
- P-2201 Directions for Future Growth of the Soviet Economy

SOVIET INDUSTRY AND TRANSPORT

- R-197 A Dollar Index of Soviet Machinery Output, 1927-28 to 1937
- RM-804 A Dollar Index of Soviet Petroleum Output, 1927-28 to 1937
- RM-951 The Problem of Defining and Measuring Railroad Capacity
- RM-1042 A Dollar Index of Soviet Coal Output, 1927/28-1937
- RM-1055 A Dollar Index of Soviet Iron and Steel Output, 1927/28-1937
- RM-1116 Productivity in Soviet Iron Mining, 1890-1960
- RM-1202 Approaches to Soviet Inter-industry Relationships
- RM-1282 A Dollar Index of Soviet Electric-power Output
- RM-1443 A Comparison of 1950 Wholesale Prices in Soviet and American Industry
- RM-1479 Industrial Training in the Soviet Union
- RM-1872 A Materials-input Index of Soviet Construction, 1927/28 to 1955—Part I
- RM-1873 A Materials-input Index of Soviet Construction, 1927/28 to 1955—Part II: Appendices
- RM-1986 A Comparison of Construction Costs in the USSR and U.S.
- RM-2213 The Soviet Role in International Civil Aviation
- RM-2432 Prices of Producers' Durables in the United States and the USSR in 1955
- RM-2454 A Materials-input Index of Soviet Construction, Revised and Extended
- RM-2495 Indexes of Soviet Industrial Output
- RM-2812-PR The Soviet Oil Offensive and Inter-bloc Economic Competition
- P-276 Trends in Soviet Industrial Productivity
- P-288 Transportation
- P-327 Employment and Labor Productivity in USSR Railroads, 1928-1950
- P-560 Soviet Heavy Industry: A Dollar Index of Output, 1927/28-1937
- P-729 Industrial Training in the Soviet Union
- P-1354 Soviet Industry Five Years after Stalin
- P-1397 Comments on *Technological Policy and Economic Calculation in Soviet Industry*, by David Granick
- P-1507 A Comment on "Costs, Freight Rates, and Location Decisions in the USSR"
- P-1569 The Soviet Industrial Reorganization of 1957
- P-1848 An Index of Soviet Industrial Output
- P-1881 Comparisons of United States and USSR National Output: Some Rules of the Game

ECONOMICS—continued

SOVIET INDUSTRY AND TRANSPORT—continued

- P-2133-1 Consumption Levels in the Soviet Union and the United States
- P-2201 Directions for Future Growth of the Soviet Economy
- P-2248-1 Soviet Capital on January 1, 1960
- P-2286 Economic Growth and Soviet-American Rivalry
- P-2360 The Soviet Oil Offensive

SOVIET NATIONAL INCOME AND PRODUCT

- R-253 Soviet National Income and Product, 1940 through 1948
- R-255 Soviet National Income and Product in 1928
- R-367-PR The Real National Income of Soviet Russia since 1928
- RM-104 The Economic Strength of the Soviet Union
- RM-122 National Income of the USSR in 1940: Preliminary Report
- RM-154 On the Territorial Coverage of Soviet Official Statistics for Years since 1939
- RM-155 Comparisons of Bergson-Heymann and Baran Calculations of Soviet National Income for 1940
- RM-278 National Income and the Disposition of Gross National Product in Adjusted Rubles, USSR, 1940
- RM-283 National Economic Accounts of the USSR in 1948: Preliminary Report
- RM-287 Disposition of National Product of the USSR in 1948 in Terms of Adjusted Ruble Prices
- RM-328 Disposition of the Gross National Product of the USSR in 1937, 1940, and 1948
- RM-367 The Economic War Potential of the United States and the Soviet Union
- RM-393 Profits and Subsidies in Soviet Economic Accounts
- RM-566 National Economic Accounts of the USSR in 1944: Preliminary Report
- RM-735 Capital Investments in the Soviet Union, 1924-1951
- RM-917 National Income of the USSR in 1928
- RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan
- RM-2101 Soviet National Income and Product, 1949-1955
- RM-2202 The Condition of the Soviet Economy
- RM-2544 Soviet National Income and Product, 1928-48: Revised Data
- P-182 The Economic War Potential of the USSR
- P-332 Arithmancy, Theomancy, and the Soviet Economy
- P-737 Recent Trends in the Soviet Economy
- P-808 Economic Development and the Rate of Interest under Dictatorial Conditions
- P-1881 Comparisons of United States and USSR National Output: Some Rules of the Game
- P-2148-1 Soviet National Income
- P-2201 Directions for Future Growth of the Soviet Economy
- P-2248-1 Soviet Capital on January 1, 1960
- T-135 Electronic Computers in the Service of the National Economy

SOVIET PLANNING: GENERAL AND INVESTMENT

- RM-393 Profits and Subsidies in Soviet Economic Accounts
- RM-488 The Law of Value and Soviet Economic Planning
- RM-539 The Choice among Investment Alternatives in Soviet Theory
- RM-1173 The New Soviet Plans for Agriculture and Consumption
- RM-1202 Approaches to Soviet Inter-industry Relationships
- RM-1342 Proposal for the Development of a Theory of Economic Growth for a Soviet-type Economy
- RM-1733 Collective Farm Investment in the USSR
- P-177 The Choice among Investment Alternatives in Soviet Economic Theory
- P-269 The Soviet Concept of Economic Regionalization
- P-332 Arithmancy, Theomancy, and the Soviet Economy
- P-737 Recent Trends in the Soviet Economy
- P-1269 Future Prospects for Soviet Economic Aid

P-1398 Comments on Wiles' *Rationality, the Market, Decentralization, and the Territorial Principle*

- P-1450 Soviet State Planning and Forced Industrialization as a Model for Asia
- P-1607 The Soviet Seven-Year Plan
- P-1768 Recent Efforts toward Coordinated Economic Planning in the Soviet Bloc
- P-1769 Soviet Foreign Aid as a Problem for U.S. Policy
- P-1943 Communist Economic Subversion: A Reappraisal
- P-2087 Sino-Soviet Economic Relations in Recent Years
- P-2133-1 Consumption Levels in the Soviet Union and the United States
- P-2201 Directions for Future Growth of the Soviet Economy
- P-2493 The 22nd Congress of the CPSU: Some Domestic Implications
- T-135 Electronic Computers in the Service of the National Economy

SOVIET POPULATION, LABOR, AND TRADE

- R-257 Labor Productivity in Soviet and American Industry
- RM-154 On the Territorial Coverage of Soviet Official Statistics for Years since 1939
- RM-703 Distribution of USSR Nonagricultural Employment, 1928–1950: A Preliminary Study
- RM-815-1 Population of Major Cities of the USSR
- RM-1116 Productivity in Soviet Iron Mining, 1890–1960
- RM-1248 The Agricultural Labor Force and Population of the USSR: 1926–41
- RM-1567 Recent Trends in Soviet Trade
- RM-2305 Terms of Trade between the Soviet Union and Smaller Communist Countries, 1955 to 1957
- RM-2494 The Control of Industrial Labor in the Soviet Union
- RM-2507-1-PR The Terms of Soviet-Satellite Trade: A Broadened Analysis
- P-126 Russian Labor Productivity Statistics
- P-260 Reliability of Estimates of Unfree Labor in the USSR
- P-289 Trends and Prospects of the Soviet Population and Labor Force
- P-327 Employment and Labor Productivity in USSR Railroads, 1928–1950
- P-449 Real Wages in the Soviet Union, 1928–1952
- P-551 Employment and Unemployment in the USSR
- P-739 Recent Trends in Soviet Trade
- P-972-RC Soviet Economic Aid in Southeast Asia: Threat or Windfall?
- P-1047 Soviet Trade and Aid: Trickle or Torrent?
- P-1598 Terms of Trade between the Soviet Union and Smaller Communist Countries, 1955 to 1957
- P-1873 The Terms of Soviet-Satellite Trade: A Broadened Analysis
- P-2087 Sino-Soviet Economic Relations in Recent Years
- P-2201 Directions for Future Growth of the Soviet Economy
- P-2544 Mutual Price Discrimination in Soviet Bloc Trade
- T-135 Electronic Computers in the Service of the National Economy

SOVIET PRICES

- R-197 A Dollar Index of Soviet Machinery Output, 1927–28 to 1937
- RM-425 The Regional Structure of Soviet Retail Prices
- RM-707-1 Retail Food Prices in the USSR, 1937–1948
- RM-767 Prices of Ordinary Rolled Steel in the Soviet Union, 1928–1950
- RM-778 Prices of Quality Rolled Steel in the Soviet Union, 1928–1950
- RM-802 Prices of Iron and Steel Products in the Soviet Union, 1928–1950: A Summary Report
- RM-803-1 Retail Prices of Manufactured Consumer Goods in the USSR, 1937–1948
- RM-804 A Dollar Index of Soviet Petroleum Output, 1927–28 to 1937
- RM-920 Prices of Basic Chemical Products in the Soviet Union, 1928–1950
- RM-1030 Prices of Nonferrous Metals in the Soviet Union, 1928 to 1950
- RM-1037 Prices of Road Building and Construction Machines, USSR, 1928–1949
- RM-1042 A Dollar Index of Soviet Coal Output, 1927/28–1937

ECONOMICS—continued

SOVIET PRICES—continued

- RM-1055 A Dollar Index of Soviet Iron and Steel Output, 1927/28–1937
- RM-1071 Prices of Paints in the Soviet Union, 1928–1950
- RM-1112 Prices of Metalworking Equipment in the Soviet Union, 1928–1951
- RM-1121 Prices of Tractors, Trucks, and Automobiles, USSR, 1928–1949
- RM-1136 Prices of Cement in the Soviet Union, 1928–1950
- RM-1186 Prices of Bricks in the Soviet Union, 1928–1950
- RM-1225 Prices of Prime Movers, USSR, 1927/28–1949
- RM-1244 Prices of Industrial Electric Power in the Soviet Union, 1928 to 1950
- RM-1258 Prices of Railroad Rolling Stock, USSR—1927/28–1949
- RM-1282 A Dollar Index of Soviet Electric-power Output
- RM-1294 A Comparison of Soviet and United States Retail Food Prices for 1950
- RM-1421 Prices of Fuelwood and Wood Products in the USSR, 1928–1950
- RM-1423 Prices of Coal and Peat in the Soviet Union, 1928–1950
- RM-1443 A Comparison of 1950 Wholesale Prices in Soviet and American Industry
- RM-1482 Prices of Miscellaneous Basic Industrial Products, USSR, 1928–1950
- RM-1497 Prices of Refined Petroleum Products in the USSR, 1928–1950
- RM-1522 Basic Industrial Prices in the USSR, 1928–1950: Twenty-five Branch Series and Their Aggregation
- RM-1557 Abbreviations for Price Handbooks Used in RAND Studies of the Prices of Soviet Basic Industrial Goods
- RM-1606 A Comparison of Soviet and United States Retail Prices for Manufactured Goods and Services in 1950
- RM-1692-1 A Comparison of Soviet and American Retail Prices in 1950
- RM-1872 A Materials-input Index of Soviet Construction, 1927/28 to 1955—Part I
- RM-1873 A Materials-input Index of Soviet Construction, 1927/28 to 1955—Part II: Appendices
- RM-1906 An Addendum to Previous USSR-U.S. Retail Price Comparisons
- RM-1919 Prices of Basic Industrial Goods in the USSR, 1950 to 1956: A Preliminary Report
- RM-1986 A Comparison of Construction Costs in the USSR and U.S.
- RM-2432 Prices of Producers' Durables in the United States and the USSR in 1955
- RM-2454 A Materials-input Index of Soviet Construction, Revised and Extended
- P-449 Real Wages in the Soviet Union, 1928–1952
- P-560 Soviet Heavy Industry: A Dollar Index of Output, 1927/28–1937
- P-789 Prices of Basic Industrial Products in the USSR, 1928–1950
- P-901 A Comparison of Soviet and American Retail Prices in 1950
- P-1881 Comparisons of United States and USSR National Output: Some Rules of the Game
- P-2544 Mutual Price Discrimination in Soviet Bloc Trade
- T-135 Electronic Computers in the Service of the National Economy

TARGETS

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-346 The German Munitions Production Index: World War II
- RM-428 Petroleum Industry of Germany during the War
- RM-815-1 Population of Major Cities of the USSR
- RM-1806 Report on the Dynamic Strength of Rigid-plastic Beams under Blast Loads
- RM-2844-PR Postattack Damage Assessment: A Conceptual Analysis
- P-301 Are We Sure about Dispersal?
- P-548 Is Dispersal Good Defense?
- P-674 Some Thoughts on the Social Structure after a Bombing Disaster
- P-1675 Why Go Deep Underground?
- P-2093 The Importance of Individual Industries for Defense Planning
- P-2124 The Importance of Individual Industries for Defense Planning: Supplemental Data
- P-2416 Economic Recovery from the Effects of Thermonuclear War

EDUCATION—See also Complex Information Processing, Mathematics, and Psychology

- RM-2473-FF Systems Analysis and Education
- RM-3009-FF Teacher Shortages and Salary Schedules
- P-1625-RC Some Economic Features of Public Education
- P-1633 The Impact of the Space Age on Engineering Education
- P-1751 Computing and Education
- P-1805 The Failure of the Universities—I: Scientific and Technological
- P-1886-FF Decisionmaking in the Schools: An Outsider's View
- P-1999 On University Courses in Materials for the Engineer
- P-2282 Reorientation of Engineers To Meet the Challenge of a Changing Technology: Industrial Aspects of the Problem
- P-2458 What To Do about Teacher Shortages

ELECTROMAGNETIC WAVE PROPAGATION

- R-389-PR Distribution of the Intensity and Polarization of the Diffusely Reflected Light over a Planetary Disk
- R-393-PR Light Scattering on Partially Absorbing Homogeneous Spheres of Finite Size
- RM-335 A Study of the Factors Affecting the Choice of Frequency for an Airborne Microwave Relay System
- RM-748 Phase Coherence of Reflections from Scatterers
- RM-2008 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
- RM-2259 On the Growth of Duty Cycle in Intermittent Communication Systems
- RM-2492 Survey of Radiometric Quantities and Units
- RM-2502 Extension of the "WKB" Approximation of High-frequency Scattering by a Dielectric Sphere—Part I: General Expressions
- RM-2740 D-layer Ionization Loss Rates
- RM-2764 Industrial Equipment Spectrum Signatures
- P-645 Radiation Patterns of Unsymmetrically Fed Prolate Spheroidal Antennas
- P-1121 Ionospheric Electric-current Systems Derived Using International Polar Year Data
- P-1171 The Maser: A New Type Molecular Amplifier for Microwave Radiation
- P-1190 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
- P-1247 Note on the Minimum Variance of Unbiased Estimates of Doppler Shift
- P-1287 Theory of the Solar Aureole—Part II: Applications to Atmospheric Models
- P-1338 Temperature Dependence of the Rayleigh Scattering Coefficient in the Atmosphere
- P-1396 Some Statistical Methods of Potential Value in Radio Wave Propagation Investigations
- P-1468 Parameter Estimation for Waveforms in Additive Gaussian Noise
- P-1528 Statistical Methods in Radio-wave Propagation
- P-1529 Functional Equations, Wave Propagation, and Invariant Imbedding
- P-1565 On the Role of Clear Sky Turbidity in Atmospheric Infrared Transmission
- P-1681 Some Comments on the Wave Propagation Study Group
- P-1710 Note on Conjugate Points of Geomagnetic Field Lines for Some Selected Auroral and Whistler Stations of the IGY
- P-1726 Remarks on Auroral Isochasms
- P-1753 Geomagnetic Control of Auroral Phenomena
- P-1788 Estimation of Doppler Shifts in Noise Spectra
- P-1795 The Geomagnetic Field in Space, Ring Currents, and Auroral Isochasms
- P-1816 Polar Auroral, Geomagnetic, and Ionospheric Disturbances
- P-1845 The Upper Atmosphere and Geomagnetism
- P-1860 Maximum Total Energy of the Van Allen Radiation Belt
- P-1863 The Survey of the Geomagnetic Field in Space
- P-1880 Atmospheric Extinction of Infrared Radiation
- P-1940 Polar Magnetic, Auroral, and Ionospheric Phenomena
- P-1957 Note on the Direction of High Auroral Arcs
- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts

ELECTROMAGNETIC WAVE PROPAGATION—continued

- P-2041 A Local Reduction of F-region Ionization Due to Missile Transit
- P-2067 Synchronization of Coherent Detectors
- P-2079 Mie Scattering with Complex Index of Refraction
- P-2249 VLF Ionospheric Reflection Coefficients: Derivation from Impedance Concepts and Values for Some Model Ionospheres
- P-2409 An Extension to VLF Reflection Coefficients
- RAT-13 Propagation of Long Waves around the Earth
- T-47 The Influence of Weak Atmospheric Inhomogeneities upon the Propagation of Sound and Light
- T-109 Radiointerference Phenomena Caused by the Ionosphere of the Moon

ELECTRONIC ENVIRONMENT STUDIES—See also Radar

- RM-2764 Industrial Equipment Spectrum Signatures
- P-1750 Radar Signal Density Predictions and Measurements
- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts
- P-2078 Measurements of Effective Radiated Power
- T-109 Radiointerference Phenomena Caused by the Ionosphere of the Moon

ELECTRONICS—See also Communications, Countermeasures and Counter-countermeasures, Guidance and Control, Infrared Studies, Navigation, Radar, Reconnaissance, and Reliability

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-40 A "Semi-Poisson" Distribution
- RM-130 A Note on Vacuum Tube Life
- RM-226 Principles of the REAC
- RM-236 Summary of REAC Experience
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-335 A Study of the Factors Affecting the Choice of Frequency for an Airborne Microwave Relay System
- RM-429 On Nicolson's Formula for Capacitance
- RM-525 RAND REAC Manual
- RM-657 Use of the Special Program Device on the 417 Tabulator
- RM-1002 The Cost of Unreliability of Air Force Airborne Electronic Equipment as Represented by the Cost of Maintenance
- RM-2110 Wide-band Magnetic Tape Recorder
- RM-2172 A Possible Transponding System for an Artificial Asteroid
- RM-2259 On the Growth of Duty Cycle in Intermittent Communication Systems
- RM-2445 Descriptive Guide to a Card Directory of U.S. Military Radio Communication Equipment
- RM-2462 Signal Detection in a Noisy World
- RM-2625 Some Results on New Classes of Matched Filters
- RM-2641 A Study of the Feasibility of Detecting Nuclear Explosions by Means of Anti-neutrinos
- RM-2764 Industrial Equipment Spectrum Signatures
- RM-2987-PR Approximate Band-pass Limiter Envelope Distributions
- RM-3015-PR A Computational Procedure for Optimizing Interplanetary Trajectories
- P-123 End-cooling of Power Tube Filaments
- P-163 Capacitance of Circular Condenser
- P-294 Applications of the Kac-Siegert Method for Finding Output Probability Densities for Receivers with Square Law Detectors
- P-305 On the Detection of a Sine Wave in Gaussian Noise
- P-339 Transient Response of Butterworth Approximations of Ideal Low-pass Filters

- P-690 A System for Cataloguing Reference Material
- P-691 File Reference
 - P-749 The Power Spectrum of the Turbulent-scattered Field
 - P-1050 On the Detection of Stochastic Signals in Additive Normal Noise—Part I
- P-1185 A Method of Computing the Inherent Accuracy with Which a Time Delay Can Be Estimated
 - P-1200 Weighted PCM
 - P-1223 On Weighted PCM and Mean Square Deviation
- P-1254 An Electronics Engineer's View of Operations Research
 - P-1305 Propagation Considerations in Space Operations
 - P-1518 Problems of Range Measurement with Special Application to the Establishment of an Orbit of an Artificial Asteroid
- P-1524 Direct-power Conversion—Part I: General Comments
 - P-1528 Statistical Methods in Radio-wave Propagation
 - P-1585 Masers and Irasers
 - P-1628 Comments on Electrical Power Supplies for Underground Shelters
 - P-1651 Augmentation of Nuclear-rocket Specific Impulse through Mechanical-Electrical Means
 - P-1657 Protection of Communications and Electronic Systems
 - P-1684 A Note on the Computation of Single-sideband Peak Power
- P-1724 Military Radio Communications Equipment Trade-offs
 - P-1775 The Effect of Delay Distortion on Data Transmission
 - P-1788 Estimation of Doppler Shifts in Noise Spectra
 - P-1907 On the Noise Temperature of Coupling Networks
 - P-1944 Electrical Power from Rockets
- P-2030 On Style in Research and Development
- P-2067 Synchronization of Coherent Detectors
 - P-2078 Measurements of Effective Radiated Power
 - P-2278-1 On a Moment Theorem for Complex Gaussian Processes
 - P-2314 Aspects of Synchronous Communication Satellites
 - P-2319 Some Limitations of Automatic Test Equipment
 - P-2341 Wave Branching Processes and Invariant Imbedding—I
 - P-2487 The Design of a Sequential Test for the Detection of Known Signal in Normal Non-white Noise
 - P-2498 Some Simple Examples of Singular Detection of Continuous Signals in Noise
 - P-2536 On the Output Probability Density Function of a Linear Device with Certain Non-gaussian Random Inputs
- RAT-9 Increase in Sensitivity of Amplifiers and Mixers in the Meter and Decimeter Wave Range
 - T-92 Theory and Applications of the Notion of Complex Signal
 - T-101 Radiation of Plasma in a Magnetic Field

FALLOUT—See Meteorology

GAME THEORY—See also Mathematics and Statistics

BEST STRATEGIES

- RM-376 A Method for Choosing among Optimum Strategies
- RM-386 "Best" Strategies
- RM-387 Some Remarks on Best Strategies
- RM-412 A Note on Best Strategies
- RM-433 Best Strategies for Continuous Games with a Continuous Payoff

CONTINUOUS GAMES

- RM-33 Two Theorems Concerning Solutions for Games with Continua of Strategies
- RM-42 Some Examples of Games with Continuous Payoff Functions
- RM-152 A Class of Games with Good, Pure Strategies
- RM-435 Games Played over Nonconvex Sets of Mixed Strategies
- RM-491 Notes on the Game with Rational Payoff

GAME THEORY—continued

CONTINUOUS GAMES—continued

- RM-501 A Class of Games with Unique Density Function Solutions
- RM-502 Games with Positive-density Solutions
- RM-510 Continuous Games with Given Strategies
- RM-549 The Pathological Nature of Certain Games with Rational Payoff
- RM-568 The Pathological Nature of Certain Games with Rational Payoff—II
- RM-593 Density of Games with Unique Solutions
- RM-597 Games with Circular Symmetry
- RM-610 Moments of the Distribution of Outcomes of a Game
- RM-611 A Game with Respective Optimal Spectra of Cardinality c and 1
- RM-620 Continuous Games with Given Unique Solutions
- RM-655 Games Concave on Each Side of the Unit Square Diagonal
- RM-705 A Game Value Characterization of Algebraic Numbers
- RM-706 A Note on Payoffs Which Vanish Almost Everywhere
- RM-752 A Second Note on Payoffs Which Vanish Almost Everywhere
- RM-818 Another Proof of the Minmax Theorem for Continuous Payoffs
- RM-889 Optimal Sets for Games over the Square
- RM-901 Solution Sets for Games on the Square
- RM-1755 Games with Payoff Discontinuities at Discrete Points
 - P-66 Games with Continuous, Convex Payoff
 - P-85 On a Theorem of Ville
 - P-100 Polynomial Games
 - P-188 On Certain Games with Transcendental Values
- P-232 On the Min Max of $\int_0^1 f(x)a(x)d(x) dt(x)$
- P-241 Reduction of Certain Classes of Games to Integral Equations
- P-248 The Theory of Infinite Games
- P-254 On a Class of Games
- P-255 Solutions of Convex Games as Fixed-points
- P-293 An Extension of the Brown-Robinson Iterative Process for Finding the Value of a Game
- P-379 A Derivative Test for Finite Solutions of Games
- P-557 A Rational Game on the Square

DISCRETE GAMES

- RM-414 Solution of a Game with Constraints
- RM-608 Factorable Games
- RM-638 On Determining the Full Set of Solutions of a Finite Game
- RM-776 Games of Survival
- RM-777 Optimal Strategies in Games of Survival
- RM-884 More on Games of Survival
- RM-1142 Order Matrices—I
- RM-1145 Order Matrices—II
- RM-1542 Information in Games with Finite Resources
- RM-1598 A Condition for the Existence of Saddle-points
- RM-3026-PR On the Nonconvergence of Fictitious Play
 - P-57 Solutions of Discrete, Two-person Games
- P-78 Some Notes on Computation of Games Solutions
- P-354 Conflicts with Imprecise Payoffs
- P-622 On Games of Survival
 - P-861 Information in Games with Finite Resources

EXAMPLES

- RM-31 Ville's Example of a Game without a Strategic Saddle-point
- RM-42 Some Examples of Games with Continuous Payoff Functions
- RM-137 A Three-move Game with Imperfect Communication
- RM-160 An Example of Bluffing with Pure Strategies
- RM-215 Solutions of a Class of Continuous Games

- RM-408 A Continuous Colonel Blotto Game
- RM-414 Solution of a Game with Constraints
- RM-424 The Symmetric Blotto Game
- RM-538 A Class of Games with Unique Solutions
- RM-549 The Pathological Nature of Certain Games with Rational Payoff
- RM-568 The Pathological Nature of Certain Games with Rational Payoff—II
- RM-718 An Infinite-dimensional Extension of a Symmetric Blotto Game
- RM-736 Continuous Blotto
- RM-791 A Pursuit Game with Incomplete Information
- RM-898 An Example of an Infinite, Nonconstant-sum Game
- RM-1316 A Game of Aiming and Evasion
- RM-1385 A Game of Aiming and Evasion: General Discussion and the Marksman's Strategies
- RM-1391 Differential Games—I: Introduction
- RM-1399 Differential Games—II: The Definition and Formulation
- RM-1411 Differential Games—III: The Basic Principles of the Solution Process
- RM-1480 The Convergence of the Discrete Analogues of Differential Games—Part I
- RM-1486 Differential Games—IV: Mainly Examples
 - P-84 Some Two-person Games Involving Bluffing
- P-235 A Game over Function Space
- P-257 Games of Pursuit
- P-557 A Rational Game on the Square
 - P-642 The Problem of Aiming and Evasion
- P-2091 An Empirical Description of the Prisoner's Dilemma Game
- P-2538 A Game Theoretic Approach to Space Vehicle Prelaunch Activities Scheduling

GAMES IN EXTENSIVE FORM

- RM-137 A Three-move Game with Imperfect Communication
- RM-268 Games with Many Moves
- RM-654 Sums of Games
- RM-747 Two Examples Concerning Behavior Strategies
- RM-759 Equivalence of Games in Extensive Form
- RM-769 Behavior Strategies in Finite Games
- RM-1320 Games with Information Lag
 - P-140 A Simplification of Games in Extensive Form
- P-168 On Games Involving Bluffing
- P-220 Symmetric Three-person Games and the Concept of an Independent Point
- P-245 An Analysis of Three-move Finite Games
 - P-265 Equivalence of Information Patterns and Essentially Determinate Games
- P-797 Games with Partial Information

GAMES OF TIMING

- RM-118 Note on Duels with Continuous Firing
- RM-131 The Noisy Duel, One Bullet Each, Arbitrary Nonmonotone Accuracy
- RM-165 A Bomber-Fighter Duel
- RM-193 A Bomber-Fighter Duel—II
- RM-206 A Generalization of the Silent Duel, Two Opponents, One Bullet Each, Arbitrary Accuracy
- RM-213 The Duel with Time of Flight Not Zero
- RM-219 A Loud Duel with Equal Accuracy Where Each Duelist Has Only a Probability of Possessing a Bullet
- RM-357 On Positive Transformations
- RM-444 A Remark on the Silent Duel with Positive Initial Accuracy, and on Associated Silent and Noisy Duels
- RM-445 The Silent Duel, One Bullet versus Two, Equal Accuracy
- RM-474 Noisy Duel, One Bullet Each, with Simultaneous Fire and Unequal Worths
- RM-641 The Noisy Duel: Existence of a Value in the Singular Case
- RM-1415 A Two-machine-gun Duel with the Bomber Turret Vulnerable
 - P-131 On Games of Timing

GAME THEORY—continued

GAMES OVER FUNCTION SPACE

- RM-737 Note on Games over a Function Space with Homogeneous Kernels
- RM-745 On Weak Convergence of Strategies in Certain Games over a Function Space
- RM-814 Minmax Theorem for a Class of Games over a Function Space
- RM-897 Reduction of Certain Games over Function Space
- RM-2265 A Class of Function-space Games
- P-235 A Game over Function Space
- P-262 A Simple Type of Game over Function Space, Convex for the Minimizing Player
- P-405 On a Class of Games over Function Space and Related Variational Problems

GAMING AND SIMULATION

- R-353 On the Epistemology of the Inexact Sciences
 - RM-1916 Data for Testing a Model of Organizational Behavior
 - RM-2117 Simulated Wars in LP-I
 - RM-2177 The Simulated Aircraft and Its Failure Model in LP-I
 - RM-2200 Cost and Performance Data from LP-I: The First Experiment in Simulation by the Logistics Systems Laboratory
- RM-2455 Misslogs: A Game of Missile Logistics
- RM-2572 The LP-II Data-processing System
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
 - P-579 Gaming as a Technique of Analysis
 - P-899 War Gaming as a Technique of Analysis
- P-1041 War Games
 - P-1056 On the Construction of a Multi-stage, Multi-person Business Game
- P-1074 Simulation in RAND's System Research Laboratory
- P-1075 Simulation in RAND's Logistics Systems Laboratory
 - P-1105 The History, Purpose, and Script of *Cogwheel*
 - P-1167 War Gaming
- P-1219 The Use of Gaming and Simulation Devices in Business
- P-1234 A First Approach to Logistics Systems Simulation
 - P-1334 The Logistics Laboratory as a Research Tool
 - P-1343 Use of a Simulation Laboratory To Study the Organization and Effectiveness of Air Force Logistics
- P-1368 On the Economic Management of Large Organizations: A Case Study in Military Logistics Involving Laboratory Simulation
 - P-1413 Top Management Decision and Simulation Processes
- P-1454 The Simulation Laboratory as a Developmental Tool
 - P-1513 On the Epistemology of the Inexact Sciences
- P-1555 The Simulation of a Large-scale Military Activity
 - P-1581 Simulation and Stimulation
 - P-1656 The Use of Simulation in Estimating Intrasquadron Logistics Requirements: A Description of LP-II, Phase 1.1
 - P-1679-RC Some Observations on Political Gaming
 - P-1689 The Use of Numerical Simulation in the Development of Inventory Policy
 - P-1773 An Introduction to War Games
 - P-1791 The Use of Simulation in Logistics Policy Research
 - P-1808 Simulation Techniques
 - P-1823 The Use of Man-Machine Simulation for Support Planning
- P-1945 Development of Man-Machine Simulation Techniques
 - P-1988 An Analysis of the Decisionmaking Functions of a Simulated Air-defense Direction Center
- P-2086 Man-Machine Simulation Progress
 - P-2223-1 Simulation and Long-range Planning for Resource Allocation
 - P-2234 The Use of Manned Simulation in the Weapon System Planning Process
 - P-2260 How Useful Are "Scientific" Tools of Management?
 - P-2264-1 Some Suggested Techniques for Data System Development

- P-2355 Game-simulation and Long-range Planning
- P-2543 A Statistical Approach to Simulation

GENERAL THEORY

- R-115 Mathematical Theory of Zero-sum Two-person Games with a Finite Number or a Continuum of Strategies
 - R-216 Theory and Applications of Games of Strategy
 - R-228 Introduction to the Theory of Games
 - R-360 Games of Strategy: Theory and Applications
- RM-243 On the Equality $\text{Min Max} = \text{Max Min}$, and the Theory of Games
- RM-366 On the Min Max of a Bilinear Form
- RM-478 Minimax Theorem for Upper and Lower Semicontinuous Payoffs
- RM-724 A Generalization of Numerical Utilities
- RM-889 Optimal Sets for Games over the Square
- RM-1286 The Derivatives of the Value of a Game
- RM-1526 Discrete Approximations to Some Differential Games
- RM-1818 Equilibrium Points in Games with Vector Payoffs
- RM-2320 A Mechanical Proof of the Min-Max Theorem
- RM-2368 A Note on Polynomial and Separable Games
- RM-2772 A Variational Approach to Differential Games
- RM-3012-PR A Differential Game without Pure Strategy Solutions on an Open Set
 - P-47 Isomorphism of Games, and Strategic Equivalence
- P-223 A Gradient Method for Approximating Saddle Points and Constrained Maxima
- P-306 New Currents in an Old Stream
- P-564 Constructive Proof of the Min-Max Theorem
 - P-717 On Differential Games with Integral Payoff
- P-742 On Differential Games with Survival Payoffs
 - P-994 Theory of Games of Strategy
- P-1026 The Game-theoretical Approach to Organization Theory
 - P-1053 The Prospects of a Unified Theory of Organizations
 - P-1062 The Theory of Games
 - P-1151 A Multimove Infinite Game with Linear Payoff
 - P-1212 Equilibrium Points in Games with Vector Payoffs
 - P-1216 A Note on Polynomial and Separable Games
 - P-1491 Prospectus for a Reorientation of Game Theory
 - P-1849 Some Military Applications of the Theory of Games
 - P-2033 The Convergence Problem for Differential Games
 - P-2205 A Variational Approach to Differential Games
 - P-2260 How Useful Are "Scientific" Tools of Management?
 - P-2298 The Rendezvous Value of a Metric Space

METHODS OF SOLVING

- RM-128 A Game-solving Technique
- RM-201 Graphical Solution of 3×3 Matrices
- RM-204 Note on the Solution of Convex Games
- RM-279 Notes on $(m \times 2)$ Evaluation Matrices for Special Systems Analysis Applications
- RM-540 Notes on the Dynamic Approach to Saddle Points and Extremum Points: Gradient Methods and the Equations of Classical Mechanics
- RM-595 Machine Method: Iterative Solution of Games
- RM-641 The Noisy Duel: Existence of a Value in the Singular Case
- RM-693 Some Remarks on the Double Description Method
- RM-858 Remark on a Theorem of Danskin
- △ ● RM-1096 On a New Iterative Algorithm for Finding the Solutions of Games and Linear Programming Problems
 - RM-1326 Continuous Iteration Method for Solution of Differential Games
 - RM-1411 Differential Games—III: The Basic Principles of the Solution Process
 - RM-3026-PR On the Nonconvergence of Fictitious Play
 - P-78 Some Notes on Computation of Games Solutions

GAME THEORY—continued

METHODS OF SOLVING—continued

- P-78B Notes on the Solution of Linear Systems Involving Inequalities
- P-103 Method of Solution in Game Theory
- P-142 Solutions of Games by Differential Equations
- P-154 An Iteration Method of Solving a Game
- P-293 An Extension of the Brown-Robinson Iterative Process for Finding the Value of a Game
- P-473 On a New Iterative Algorithm for Finding the Solutions of Games and Linear Programming Problems
- P-1459 Solving Two-move Games with Perfect Information

MODELS AND APPLICATIONS

- RA-15078 Contributions to Lanchester Attrition Theory
- R-313 Some Aspects of the Mathematical Theory of Control Processes
- RM-6 Combat between Heterogeneous Forces
- RM-12 A Note on the Lanchester Equations
- RM-13 A Second Note on the Lanchester Equations
- RM-101 A Hidden-target Model
- RM-197 Application of Theory of Games to Identification of Friend and Foe
- RM-202 Total Reconnaissance with Total Countermeasures: Simplified Model
- RM-203 Solutions of a Special Reconnaissance Game
- RM-205 A Tactical Reconnaissance Model
- RM-208 Reconnaissance in Game Theory
- RM-241 Comparison of Reconnaissances
- RM-319 Local Defense of Targets of Equal Value
- RM-320 Local Defense of Targets of Equal Value: Extension of Results
- RM-329 Local Defense of Targets of Equal Value: Completion of Results
- RM-359 n Targets of Differing Vulnerability with Attack Stronger than Defense
- RM-517 Expected Results of a Bombing Strike, Including Reconnaissance
- RM-522 Curves Giving Expected Results of a Bombing Strike
- RM-528 Military Doctrine of Decision and the von Neumann Theory of Games
- RM-645 On a Geometrical Game Connected with Sequential Analysis
- RM-1171 A Tactical Air Game
- RM-1335 Optimal Tactics in a Multistrike Air Campaign
- RM-1877 Optimal Employment of Tactical Air Forces in Theater Air Tasks: A Game-theoretic Analysis
- RM-2137 Optimal Employment of Tactical Air Forces in Theater Air Tasks—II: A Game-theoretic Analysis
- RM-2398 A Game Solution to a Missile-launching Scheduling Problem
- RM-2399 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- RM-2476 Symmetric Games
- RM-2648 Values of Large Games—I: A Limit Theorem
- RM-2649 Values of Large Games—II: Oceanic Games
- RM-2650-PR Values of Large Games—III: A Corporation with Two Large Stockholders
- RM-2651 Values of Large Games—IV: Evaluating the Electoral College by Montecarlo Techniques
- RM-2723 Optimal Timing in Missile Launching: A Game-theoretic Analysis
- RM-2860-PR Values of Large Games—V: An 18-Person Market Game
- RM-2912-PR Values of Games with Infinitely Many Players
- RM-3026-PR On the Nonconvergence of Fictitious Play
- P-106 Total Reconnaissance with Total Countermeasures: Simplified Model
- P-266 The Uses and Limitations of Mathematical Models, Game Theory, and Systems Analysis in Planning and Problem Solution
- P-1063 A Tactical Air Game
- P-1314 The Foundations and Advances in Game Theory
- P-1342 The Reciprocal Fear of Surprise Attack
- P-1375 Use of Mathematical Models for Logistical Planning

- P-1385 Re-interpretation of the Solution Concept for "Non-cooperative" Games
- P-1386 For the Abandonment of Symmetry in the Theory of Cooperative Games
- P-1392 The Solutions of a Symmetric Market Game
- P-1533 A Multimove Allocation Game
- P-1592 A Game Theory Analysis of Tactical Air War
- P-1849 Some Military Applications of the Theory of Games
- P-1914 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- P-2072 The Implications of Some Game-theoretic Analyses for War Gaming
- P-2131 New Directions in the Application of Game Theory: An Abstract
- P-2538 A Game Theoretic Approach to Space Vehicle Prelaunch Activities Scheduling
- T-65 A Tank Duel with Game-theoretic Implications

NON-ZERO-SUM AND n -PERSON GAMES

- RM-212 On Non-zero-sum Games and Stochastic Processes
- RM-250 On a Particular Non-zero-sum Game
- RM-427 A Reduction of General Two-person Games without Side Payments
- RM-484 Equilibrium Points in Game Theory
- RM-615 n -Person Games: An Example and a Proof
- RM-656 Notes on the n -Person Game—I: Characteristic-point Solutions of the Four-person Game
- RM-670 Notes on the n -Person Game—II: The Value of an n -Person Game
- RM-679 Games against Nature
- RM-789-1 Some Experimental Games
- RM-817 Notes on the n -Person Game—III: Some Variants of the von Neumann-Morgenstern Definition of Solution
- RM-881 Notes on the n -Person Game—IV: A Theorem on C-Stable Sets
- RM-898 An Example of an Infinite, Nonconstant-sum Game
- RM-916 Reasonable Outcomes for n -Person Games
- RM-936 An Experiment in Mental Generation of Random Numbers
- RM-948 Some Experimental n -Person Games
- RM-1005 n -Person Games—V: Stable-set Solutions Including an Arbitrary Closed Component
- RM-1337 On Multi-stage Games with Imprecise Payoff
- RM-1384 Simple Games: An Outline of the Descriptive Theory
- RM-1533 A Symmetric Market Game
- RM-2533 Notes on n -Person Games—VI: On Solutions that Exclude One or More Players
- RM-2648 Values of Large Games—I: A Limit Theorem
- RM-2649 Values of Large Games—II: Oceanic Games
- RM-2650-PR Values of Large Games—III: A Corporation with Two Large Stockholders
- RM-2651 Values of Large Games—IV: Evaluating the Electoral College by Montecarlo Techniques
- RM-2860-PR Values of Large Games—V: An 18-Person Market Game
- RM-2912-PR Values of Games with Infinitely Many Players
- P-172 Two-person Cooperative Games
- P-193 A Further Generalization of the Kakutani Fixed-point Theorem, with Applications to Nash Equilibrium Points
- P-222 A Comparison of Treatments of a Duopoly Situation
- P-263 A Preference Experiment
- P-295 A Value for n -Person Games
- P-297 Quota Solutions of n -Person Games
- P-303 A Social Equilibrium Existence Theorem
- P-321 University of Michigan—RAND Summer Sessions Papers
- P-629 Markets as Cooperative Games
- P-888 A Solution Containing an Arbitrary Closed Component
- P-1166 Game Theory
- P-1716 Randomization of Threats and Promises
- P-2131 New Directions in the Application of Game Theory: An Abstract
- P-2169 Symmetric Solutions of Some General n -Person Games
- P-2277 Simple Games: An Outline of the Descriptive Theory

GEOPHYSICS—See also Meteorology and Physics

- R-348 A Method of Concealing Underground Nuclear Explosions
- R-368 Geomagnetic Field Lines in Space
- R-393-PR Light Scattering on Partially Absorbing Homogeneous Spheres of Finite Size
RM-1153-AEC Ionization of Radioactive Particles in the Free Air
- RM-1762 Estimating Ground Motions Resulting from Air-induced Ground Shocks
- RM-1900 Visual Detection of Light Sources On or Near the Moon
- RM-1941 Artificial Satellites of the Moon
- RM-1967 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface
- RM-1969 Radioactive Contamination from a Multibomb Campaign
RM-2006 Rate of Fall through the Atmosphere of Irregularly Shaped Particles
- RM-2008 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
- RM-2133 Theory of the Solar Aureole—Part II: Applications to Atmospheric Models
- RM-2161 Outline of a Study on Extraterrestrial Base Design
- RM-2174 Lunar Base Study Jury Report: Evaluation of an Experiment in Creative Design
Conducted with College Students
- RM-2275 Recent Results of High-altitude Research by Means of Rockets and Satellites
- RM-2286 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
RM-2322 Evaluation of the Effect of Environment on Refueling Operations
- RM-2456-AEC Probing the Earth with Nuclear Explosions
- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
RM-2492 Survey of Radiometric Quantities and Units
- RM-2502 Extension of the "WKB" Approximation of High-frequency Scattering by a Dielectric Sphere—Part I: General Expressions
- RM-2562-AEC Concealment of Underground Explosions
- RM-2617 Geological Covering Materials for Deep Underground Installations
- RM-2665-AEC The Effect of Plasticity on Decoupling of Underground Explosions
- RM-2696-AEC Power Recovery from the Kilauea Iki Lava Pool
- RM-2932-PR Concerning a Certain Effect in the Field of Meteor Aerodynamics
RM-3005-PR The Irrelevance of the GNOME Shot to Decoupling
P-701-AEC Ionization of Radioactive Particles in the Free Air
- P-1107 The Graphical Integration of the One-parameter Model with Terrain Effects
- P-1121 Ionospheric Electric-current Systems Derived Using International Polar Year Data
- P-1190 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
- P-1210 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface
- P-1287 Theory of the Solar Aureole—Part II: Applications to Atmospheric Models
- P-1335 Space-vehicle Environment
- P-1338 Temperature Dependence of the Rayleigh Scattering Coefficient in the Atmosphere
- P-1402 Satellite Weather Reconnaissance
- P-1426 Some Remarks on the Nature and Origin of Noctilucent Cloud Particles
- P-1442 Some Aspects of Astronautics
- P-1446 Multiple Image Printing for Planetary Photography
- P-1481 The Propagation of Errors in Keplerian Orbits
- P-1496 Atmospheric Perturbations of Artificial Satellites
- P-1501 I.G.Y. Rockets and Satellites: A Report on the Moscow Meetings, August 1958
- P-1509 Spectrographic Observations of the Blue Haze in the Atmosphere of Mars
- P-1535 On Lunar and Planetary Experiments
- P-1541 Lines of Force of the Geomagnetic Field in Space
- P-1553 Cosmic Terrestrial Relations
- P-1559 The Status and Improvement of Physical Constants Needed for Precision Trajectories
- P-1561 Satellite Perturbations Resulting from Lunar and Solar Gravitational Effects
P-1564 Upper-atmosphere Properties Based on Rocket and Satellite Data
- P-1565 On the Role of Clear Sky Turbidity in Atmospheric Infrared Transmission
- P-1594 A Seismic Scaling Law for Underground Explosions
- P-1626 Some Preliminary Scientific Findings of the International Geophysical Year
- P-1631 Magnetic Storms

- P-1710 Note on Conjugate Points of Geomagnetic Field Lines for Some Selected Auroral and Whistler Stations of the IGY
- P-1712 Meteors: Frequency, Size, and Depth of Penetration
- P-1717 Review of I.G.Y. Upper-air Results
- P-1726 Remarks on Auroral Isochasms
- P-1727 The Summertime Reversal of Winds in the Lower Stratosphere
- P-1753 Geomagnetic Control of Auroral Phenomena
- P-1759 Transient Effects in the Distribution of Carbon-14 in Nature
- P-1795 The Geomagnetic Field in Space, Ring Currents, and Auroral Isochasms
- P-1801 A Scientist's Notes on the Cold War
- P-1813 The Upper Atmosphere as Observed with Rockets and Satellites
- P-1816 Polar Auroral, Geomagnetic, and Ionospheric Disturbances
- P-1824 The Mutual Attraction of Cloud Droplets in the Electrostatic Field of the Atmosphere
- P-1829 Dynamic Similarity and the Modeling of Cloud Droplets
- P-1845 The Upper Atmosphere and Geomagnetism
- P-1860 Maximum Total Energy of the Van Allen Radiation Belt
- P-1863 The Survey of the Geomagnetic Field in Space
- P-1876 Upper Atmosphere Studies
- P-1879 The Accuracy of Winds Derived by the Radar Tracking of Chaff at High Altitudes
- P-1880 Atmospheric Extinction of Infrared Radiation
- P-1892 How Good Is the Lunik III Moon Photography?
- P-1895 The Evaluation of the Effect of the Environment on a Complex Operation
- P-1920 A Comparison of Hydrodynamic and Electrostatic Forces on Cloud Droplets
- P-1921 The Vertical Motion of Solid Spheres in the Atmosphere
- P-1940 Polar Magnetic, Auroral, and Ionospheric Phenomena
- P-1957 Note on the Direction of High Auroral Arcs
- P-1960 Some Electrostatic Cloud-droplet Collision Efficiencies
- P-1972 A Preliminary Computation of Pressure and Temperature between 100 and 800 Kilometers
- P-1977 Geomagnetic Control of the Van Allen Radiation Belts
- P-2003 Temperature and Circulation of the Venus Atmosphere
- P-2007 Some Consequences of Local Acceleration of Auroral Primaries
- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts
- P-2035 Geomagnetism in Relation to Aeronomy
- P-2066 Surface Waves in an Elastic Half-space
- P-2101 Theory of Auroral Morphology
- P-2111-AEC Probing the Earth with Nuclear Explosions
- P-2193 The Upper Atmosphere as Observed with Rockets and Satellites
- P-2215 An Extension of the Karal-Keller Asymptotic Theory of Wave Propagation and Its Application to Explosive Sources
- P-2224 Correlation of Rock Properties by Statistical Methods
- P-2329 The Effect of Plasticity on Decoupling of Underground Explosions
- P-2370 Analysis of the Formation of Meteor Crater, Arizona: A Preliminary Report

GUIDANCE AND CONTROL—See also Electronics, Navigation, Radar, and Space Flight

- R-136 Effect of Missile Dynamics on Flight Path
- RM-335 A Study of the Factors Affecting the Choice of Frequency for an Airborne Microwave Relay System
- RM-1220 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements
- RM-1298 Effects of Impulsive Deflections on Ballistic Missile Trajectories
- RM-1321 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements: Minimum RMS Error in Computed Position
- RM-1852 An Application of Superconductivity to Inertial Navigation
- RM-2264 Preliminary Analysis of a Satellite Recovery System

GUIDANCE AND CONTROL—continued

- RM-2276 Minimal Impulse Requirements for Disorbiting Satellites
- RM-2323 A Generalized Formulation for Inertial Navigators and Gravitationally Stabilized Satellites
- RM-2527 General Equations of Motion of a Satellite in a Gravitational Gradient Field
- RM-2581 A Discussion of a Midcourse Guidance Technique for Space Vehicles
- RM-2592 The Possible Use of Atomic Nuclei as a Direction Reference in Inertial Space
- RM-2671 A Method for Determining Approximate Propulsion Cutoff Conditions for Ballistic Interplanetary Trajectories
- RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
- RM-3015-PR A Computational Procedure for Optimizing Interplanetary Trajectories
 - P-1021 Tracking and Communication for a Moon Rocket
 - P-1044 Principles of Self-contained Navigation
 - P-1407 On the Rotational Motion of a Body Re-entering the Atmosphere
- P-1430 Orientation and Control
- P-1481 The Propagation of Errors in Keplerian Orbits
- P-1559 The Status and Improvements of Physical Constants Needed for Precision Trajectories
- P-1568 A Discussion of Space Vehicle Guidance Problems
- P-1665 A Discussion of Several Concepts Used in the Optimization of Control Systems by Dynamic Programming
 - P-1864 Ascent Guidance for a Satellite Rendezvous
- P-1874 Design and Operation of Ground Guidance Systems
- P-1908 Propulsion Requirements for Rendezvous in Orbit
- P-1967 Cryogenic Gyros
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
 - P-2177-1 The Optimization of Multi-stage Orbit Transfer Processes by Dynamic Programming
 - P-2304 Nuclear Gyros
 - P-2402 A Computational Procedure for Optimal Control Problems with State Variable Constraint
 - P-2522 Western Electronic Show and Convention (WESCON), San Francisco, California, 1961
- T-24 The Perturbation of Pendulum and Gyroscope Instruments by Acceleration of the Vehicle
- T-44 *Red Star* Series on Guided Missiles—Part I: Construction and Methods of Application
- T-54 Possibilities of Transition from an Elliptical Orbit to a Circular Orbit, and Vice Versa
- T-85-PR The Determination of Orbits

HUMAN ENGINEERING—See also Space Flight

- RM-2542 The Sabatier Reaction for Inorganic Recovery of Oxygen in Manned Space Capsules
- RM-2668 Design Criteria for Rotating Space Vehicles
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography
- RM-2835-PR Operational and Human Factors in Planning Automated Man-Machine Checkout Systems
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
- P-1304 Certain Ecological Aspects of a Closed Lunar Base
- P-1438 Food Preservation
 - P-1577 Environmental Requirements for Extended Occupancy of Manned Satellites
- P-1636 Some Weight Considerations for Manned Lunar Missions
- P-1669 Space Flight for Man
- P-1680 Triangle: Man, Machine, Space
- P-1693 Main Street and Mars
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
- P-2051 Manpower Planning for the Space Age

- P-2310 The Allocation of Functions between Man and Machines in Automated Systems
- P-2319 Some Limitation of Automatic Test Equipment
- P-2332 Motivational Problems in Human-Computer Operations
- P-2337 Human Factors in Systems Research

INFRARED STUDIES—See also Countermeasures and Counter-countermeasures, Defense Studies, Electronics, and Radar

- RM-793-1 Infrared Radiation from Celestial Bodies
- RM-2502 Extension of the "WKB" Approximation of High-frequency Scattering by a Dielectric Sphere—Part I: General Expressions
- RM-2625 Some Results on New Classes of Matched Filters
- P-581 A Note on Infrared Stellar Magnitudes
- P-897 Atmospheric Transmission
- P-1299 Meteorological Aspects of Infrared Operations
- P-1565 On the Role of Clear Sky Turbidity in Atmospheric Infrared Transmission
- P-1585 Masers and Irasers
- P-1697 A Broad Look at the Performance of Infrared Detectors
- P-1844 Infrared Detection by Ideal Irasers and Narrow Band Counters
- P-1880 Atmospheric Extinction of Infrared Radiation
- P-2046 On the Problem of Ballistic Missile Defense
- P-2047 Interactions of Infrared Radiation with the Atmosphere: A Guide to the Modern Literature
- P-2079 Mie Scattering with Complex Index of Refraction
- P-2129 Infrared

LANGUAGE—See also Mathematics

DATA PROCESSING

- RM-2064 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- RM-2065 Studies in Machine Translation—4: Manual for Pre-editing Russian Scientific Text
- RM-2068 Studies in Machine Translation—8: Manual for Postediting Russian Text
- RM-2069 Studies in Machine Translation—9: Bibliography of Russian Scientific Articles
- RM-2538 Studies in Machine Translation—10: Russian Sentence-structure Determination
- RM-2646 Grouping and Dependency Theories
- RM-2655 Studies in Machine Translation—12: A Glossary of Russian Physics
- RM-2916-PR Research Procedures in Machine Translation
- RM-3007-PR Studies in the Theory of Computational Algorithms—1: Formalization, Computability, Representation, and Analysis Problems
- P-1588 The Use of Machines in the Construction of a Grammar and Computer Program for Structural Analysis
- P-1624 Studies in Machine Translation—8: Manual for Postediting Russian Text
- P-1632 Order of Subject and Object in Scientific Russian When Other Differentia Are Lacking
- P-1720 A Russian Structure for Comparison
- P-1771 Translation of Artificial Languages by Compiler Programs
- P-1866 Automatic Language-data Processing in Sociology
- P-1910 Grouping and Dependency Theories
- P-1926 MIMIC: A Translator for English Coding
- P-1929 An Introduction to Information Processing Language V
- P-1941 Machine Translation of Russian Prepositions
- P-1962 Automatic Content Analysis: Some Entries for a Transformation Catalog
- P-1978 Governors of the Conjunction *UTO*
- P-1984 Basic Principles and Technical Variations in Sentence-structure Determination
- P-2197 The Nature of Data in Language Analysis
- P-2279 A Logician's View of Language Data Processing
- P-2315 Dependency Systems and Phrase Structure Systems
- P-2437 Development of a Business Language

LANGUAGE—continued

MACHINE TRANSLATION

- RM-2060 Studies in Machine Translation—2: Research Methodology
- RM-2061 Studies in Machine Translation—5: Manual for Key punching Russian Scientific Text
- RM-2063 Studies in Machine Translation—1: Survey and Critique
- RM-2064 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- RM-2065 Studies in Machine Translation—4: Manual for Pre-editing Russian Scientific Text
- RM-2066-1 Studies in Machine Translation—6: Manual for Coding Russian Grammar
- RM-2068 Studies in Machine Translation—8: Manual for Postediting Russian Text
- RM-2069 Studies in Machine Translation—9: Bibliography of Russian Scientific Articles
- RM-2538 Studies in Machine Translation—10: Russian Sentence-structure Determination
- RM-2646 Grouping and Dependency Theories
- RM-2655 Studies in Machine Translation—12: A Glossary of Russian Physics
- RM-2916-PR Research Procedures in Machine Translation
- P-1218 Pairs of Russian Words with High Correlation
- P-1241 A Glossary of Russian Physics on Punched Cards
- P-1251 Studies in Machine Translation—2: Research Methodology
- P-1321 Automatic Computers in Machine-translation Research
- P-1328 Linguistic Analysis in Machine Translation Research
- P-1352 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- P-1624 Studies in Machine Translation—8: Manual for Postediting Russian Text
- P-1632 Order of Subject and Object in Scientific Russian When Other Differentia Are Lacking
- P-1720 A Russian Structure for Comparison
- P-1771 Translation of Artificial Languages by Compiler Programs
- P-1866 Automatic Language-data Processing in Sociology
- P-1896 Soviet Research in Machine Translation
- P-1900 Linguistic Research at The RAND Corporation
- P-1909 Glossary Lookup Made Easy
- P-1910 Grouping and Dependency Theories
- P-1926 MIMIC: A Translator for English Coding
- P-1941 Machine Translation of Russian Prepositions
- P-1978 Governors of the Conjunction *UTO*
- P-1984 Basic Principles and Technical Variations in Sentence-structure Determination
- P-1989 A Digital Simulation of an Aided Adaptive Character Reading Machine
- P-1990 An Aided Adaptive Character Reader for Machine Translation of Languages
- P-2142 New Areas of Application of Computers
- P-2197 The Nature of Data in Language Analysis
- P-2206 Some Linguistic Problems of Russian Graphic Abbreviations
- P-2315 Dependency Systems and Phrase Structure Systems
- P-2327 Dictionary Problems in Machine Translation
- P-2349 Experiments with a Heuristic Compiler
- P-2437 Development of a Business Language

LIMITED WAR—See Operations

LOGISTICS—See also Aircraft, Cost Analysis Studies, Economics, Mathematics, and Operations

DATA PROCESSING

- RM-1639-1 Research and Development of a New Data-processing System for Air Force Logistics
- RM-1647 A Concept of Mechanized Transportation Data Processing
- RM-1754 A Revised Data-processing System for Managing War Reserve Stocks of Aircraft Spare Parts
- RM-2013 Electronic Data-processing Control of Air Force Spare-parts Inventories

- RM-2232 A Data-processing Concept for Air Force Bases
- RM-2269 The Next Step in Air Force Centralization of Inventory Recordkeeping and Supply Data Processing
- RM-2483 The Design of Complex Management Control Systems
- RM-2681 The Role of Data Input in Automatic Data Processing Systems
- RM-2702 An Examination of the Use of Statistical Aggregates To Improve Management Control of Large Organizations
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-3010-PR Data Description for DETAB-X (Decision Table, Experimental)
- RM-3021-PR Optimal Capacity Scheduling
- P-860 RAND Research on a Data-processing System for the United States Air Force
- P-952 Large Data-handling Equipment as a Commercial Tool
- P-991 Some Principles for a Data-processing System in Logistics
- P-1230 Contrasts in Large File Memories for Large-scale Computers
- P-1617 Experiments in Single-point Data Processing in a Controlled Environment
- P-1783 Systems Design for Management Automation
- P-1932 Sixty Years of Growth in Computing and Data-processing Capability
- P-1988 An Analysis of the Decisionmaking Functions of a Simulated Air-defense Direction Center
- P-2050 An Example of Man-Machine Simulation in Logistics Research
- P-2053 The Effect of Maintenance and Reliability on the Operational Effectiveness of an Interceptor Squadron
- P-2115 Experience in the Use of a Simulation Laboratory in the Design of a Management Information System
- P-2195 A Simulation Model for Data System Analysis
- P-2246 The Role of Data Input in Automatic Data Processing Systems
- P-2319 Some Limitations of Automatic Test Equipment
- P-2322 The Use of Manned Simulation in the Design of an Operational Control System
- P-2337 Human Factors in Systems Research
- P-2437 Development of a Business Language
- P-2447 Systematic Methods for Programming Simplification
- P-2521 Quality Control and Reliability for Total Weapon System
- P-2543 A Statistical Approach to Simulation
- P-2557 A Data Processing System for State and Local Governments

LOGISTICS SYSTEMS LABORATORY

- R-323 Laboratory Evaluation of Supply and Procurement Policies
- RM-1924 First Tooling-up Exercise for Logistics Systems Laboratory (October–November, 1956)
- RM-1961 Second Tooling-up Exercise of Logistics Systems Laboratory (January–February, 1957)
- RM-1993 Logistics Laboratory Problem I after Two (Simulated) Years
- RM-2117 Simulated Wars in LP-I
- RM-2177 The Simulated Aircraft and Its Failure Model in LP-I
- RM-2200 Cost and Performance Data from LP-I: First Experiment in Simulation by Logistics Systems Laboratory
- RM-2220 Implementing Logistics Policies in Laboratory Problem I (LP-I)
- RM-2536 The Use of Bayesian Techniques for Predicting Spare-parts Demand
- RM-2572 The LP-II Data-processing System
- RM-2701 Application of the Bayes Technique to Spare-parts Demand Prediction
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
- P-973 The Logistics Laboratory: Hopes and Plans
- P-1075 Simulation in RAND's Logistics Systems Laboratory
- P-1234 A First Approach to Logistics Systems Simulation
- P-1334 The Logistics Systems Laboratory as a Research Tool
- P-1343 Use of a Simulation Laboratory To Study the Organization and Effectiveness of Air Force Logistics

LOGISTICS—continued

LOGISTICS SYSTEMS LABORATORY—continued

- P-1368 On the Economic Management of Large Organizations: A Case Study in Military Logistics Involving Laboratory Simulation
- P-1375 Use of Mathematical Models for Logistical Planning
- P-1415 A First Experiment in Logistics System Simulation
- P-1454 The Simulation Laboratory as a Developmental Tool
- P-1456 Simulation in RAND's Logistics Systems Laboratory: Laboratory Problem I
- P-1457 Communications Analysis in LP-I
- P-1555 The Simulation of a Large-scale Military Activity
- P-1615 Communications and Control Requirements in the Air Force Logistics System
- P-1634 Integration of Modeling and Simulation in Organizational Studies
- P-1656 The Use of Simulation in Estimating Intrasquadron Logistics Requirements: A Description of LP-II, Phase 1.1
- P-1780 The Use of Man-Machine Simulation in the Design of Control Systems
- P-1791 The Use of Simulation in Logistics Policy Research
- P-1808 Simulation Techniques
- P-1823 The Use of Man-Machine Simulation for Support Planning
- P-1945 Development of Man-Machine Simulation Techniques
- P-2050 An Example of Man-Machine Simulation in Logistics Research
- P-2086 Man-Machine Simulation Progress
- P-2115 Experience in the Use of a Simulation Laboratory in the Design of a Management Information System
- P-2195 A Simulation Model for Data System Analysis
- P-2223-1 Simulation and Long-range Planning for Resource Allocation
- P-2234 The Use of Manned Simulation in the Weapon System Planning Process
- P-2302 Maintenance Scheduling Decisions and the Importance of Information
- P-2317 A Malfunction-generation Model for a Manned Simulation of ICBM Logistics
- P-2322 The Use of Manned Simulation in the Design of an Operational Control System
- P-2337 Human Factors in Systems Research
- P-2355 Game-simulation and Long-range Planning
- P-2467 Appraisal of Laboratory Simulation Experiments
- P-2521 Quality Control and Reliability for Total Weapon System
- P-2543 A Statistical Approach to Simulation

MAINTENANCE

- R-358 Automatic Checkout Equipment: Employment and Design Considerations
- R-382 Influence of Resource and Policy Changes on Aircraft Capabilities
- RM-730 Time, Equipment, and Costs To Repair Cratered Runways
- RM-2131 Management Information for Maintenance and Operation of Strategic Missile Force
- RM-2365 Supply and Depot-repair Interactions: A Case Study of Electronics Support
- RM-2374 The Base Maintenance-operations Model Used in RAND Logistics Research
- RM-2418 The Base Repair Cycle for the F-102 Fire Control System
- RM-2451 A Model for Assessing the Effect of Maintenance on Missile Launch Probability
- RM-2455 Misslogs: A Game of Missile Logistics
- RM-2508 The Measurement of Missile Reliability in Pre-launch Operating Environments
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- RM-2656 Base-depot Requisitioning Pipeline Times
- RM-2685 Standardization of Automatic Test and Checkout Equipment: A Preliminary Discussion
- RM-2731 An Experiment in Aircraft Status Prediction
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography
- RM-2810-PR (Abr.) Rules for Planned Replacement of Aircraft and Missile Parts

- RM-2835-PR Operational and Human Factors in Planning Automated Man-Machine Checkout Systems
- RM-2989-PR Solution of a Simple Overhaul Problem
- RM-3014-PR When To Stop Sampling and Initiate Product Improvement
- P-818 Maintenance of a Group of Machines Utilized Intermittently and Subject to Several Types of Malfunctions—I: Operational Requirements and Resource Allocations
- P-819 Some Queueing Problems in Machine Maintenance
- P-929 A Failure Model for Equipments Undergoing Complex Operation
- P-1362 Design of a Management Information System
- P-1424 An Econometric Study of Aircraft Malfunction Behavior
- P-1548 A Simulation Model of Air Force Maintenance Operations
- P-1552 Random Variations and Sampling Models in Production Economics
- P-1629 The Advantages of Functional Packaging of Electronic Equipment
- P-1672 Measuring the Reliability of Equipments in Operating Environments
- P-1685 The Aggregation of Servicing Facilities in Queueing Processes
- P-1696 An Analytical Model for Developing Optimal Ballistic Missile Maintenance Procedures
- P-1810 Measuring Missile Reliability in Pre-launch Environments
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1981 Support Resources
- P-1996 Optimal Inventory Policy for Serviceable and Repairable Stocks
- P-1997 Optimizing a Prelaunch Checkout
- P-2053 The Effect of Maintenance and Reliability on the Operational Effectiveness of an Interceptor Squadron
- P-2074 Optimal Replacement and Inspection of Stochastically Failing Equipment
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
- P-2153 Standards, Standardization, and Test Equipment
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2302 Maintenance Scheduling Decisions and the Importance of Information
- P-2317 A Malfunction-generation Model for a Manned Simulation of ICBM Logistics
- P-2362 On the Determination of Occupational Categories in an Organization
- P-2435 Status Prediction of Scheduled Equipment
- P-2453 Throw-away Maintenance Policies
- P-2459 Human Factors Aspects in Maintainability
- P-2563 Planned Replacement
- P-2574 Problems of Support Planning

MISCELLANEOUS

- R-382 Influence of Resource and Policy Changes on Aircraft Capabilities
- RM-614 Note on the Formulation of the Study of Logistics
- RM-1357 Confidence Intervals for Poisson Parameters in Logistics Research
- RM-1508 Some Implications of "Weapons System Support" by AMC
- RM-1640 The Relation of Aircraft Status Data to the Logistics System
- RM-1785 Costs and Benefits in Mathematical Programming
- RM-1786 Relationships between Weapons and Logistics Expenditures
- RM-1817 Air Force Logistics: Some Recent Developments
- RM-2086 Baselogs: A Base Logistics Management Game
- RM-2232 A Data-processing Concept for Air Force Bases
- RM-2387 Publications of the Logistics Department—II
- RM-2455 Misslogs: A Game of Missile Logistics
- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2514 Search Rules for Automatic Fault Location
- RM-2587 An Application of a Network Flow Model to Personnel Planning
- RM-2611 Concepts for Estimating Air Force Manpower Requirements for Planning Purposes
- RM-2681 The Role of Data Input in Automatic Data Processing Systems
- RM-2767 Spare Parts Inventories for NATO
- RM-3014-PR When To Stop Sampling and Initiate Product Improvement
- P-758 Logistics and RAND: The First Two Years
- P-855 Air Force Logistics: Some Recent Developments

LOGISTICS—continued

MISCELLANEOUS—continued

- P-936 Costs and Benefits in Mathematical Programming
- P-1036 Relationships between Weapons and Logistics Expenditures
- P-1159 Economic Problems in Air Force Logistics
- P-1179 An Economist Looks at Air Force Logistics
- P-1193 A Concept of Stability in Manpower Planning
- P-1262 Air Force Logistics: From Research to Policy
- P-1431 Space-flight Ground-facility-requirements Problems: Launching Facilities
- P-1615 Communications and Control Requirements in the Air Force Logistics System
- P-1623 Reliability, Quality Control, and Simulation
- P-1694 Pitfalls in Analysis
- P-1787 The Support of Future Weapons
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1868 Logistics Research and Management Science
- P-2234 The Use of Manned Simulation in the Weapon System Planning Process
- P-2246 The Role of Data Input in Automatic Data Processing Systems
- P-2421 Various Properties of the Poisson Distribution
- P-2567 Economic-physical Trade-offs in Scheduling Missile System Checkouts
- P-2574 Problems of Support Planning

MISSILES

- R-358 Automatic Checkout Equipment: Employment and Design Considerations
- RM-2131 Management Information for the Maintenance and Operation of the Strategic Missile Force
- RM-2451 A Model for Assessing the Effect of Maintenance on Missile Launch Probability
- RM-2455 Misslogs: A Game of Missile Logistics
- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2508 The Measurement of Missile Reliability in Pre-launch Operating Environments
- RM-2514 Search Rules for Automatic Fault Location
- RM-2572 The LP-II Data-processing System
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- RM-2835-PR Operational and Human Factors in Planning Automated Man-Machine Checkout Systems
- RM-2989-PR Solution of a Simple Overhaul Problem
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
- P-1696 An Analytical Model for Developing Optimal Ballistic Missile Maintenance Procedures
- P-1810 Measuring Missile Reliability in Pre-launch Environments
- P-1823 The Use of Man-Machine Simulation for Support Planning
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1981 Support Resources
- P-1997 Optimizing a Prelaunch Checkout
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
- P-2115 Experience in the Use of a Simulation Laboratory in the Design of a Management Information System
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2302 Maintenance Scheduling Decisions and the Importance of Information
- P-2317 A Malfunction-generation Model for a Manned Simulation of ICBM Logistics
- P-2521 Quality Control and Reliability for Total Weapon System
- P-2567 Economic-physical Trade-offs in Scheduling Missile System Checkouts

SUPPLY

- R-292 Characteristics of Demand for Aircraft Spare Parts
- R-323 Laboratory Evaluation of Supply and Procurement Policies
- RM-1190 Some Characteristics of Manufacturers' Parts Numbers Now Included in Air Force Catalogs

- RM-1296 Consistency Problems in the Military Supply System
- RM-1297 Analysis of the Demand Patterns for B-47 Airframe Parts at Air Base Level
- RM-1300 Predictability of Demand for B-47 Airframe Spare Items
- RM-1392 The Cost of Various Base Stocking and Requisitioning Policies for Aircraft Spare Parts
- RM-1402 A Summary of Some Base Supply Activity and Workload Reports
- RM-1413 The Prediction of Demand for Aircraft Spare Parts Using the Method of Conditional Probabilities
- RM-1417 A Proposal for a New Air Force Supply Procedure
- RM-1431 Analysis of Base Stockage Policies
- RM-1519 A Model of the Procurement-Repair Decision for a Spare Item
- RM-1539 Simple Distribution Functions for Inventory Control
- RM-1621 A Technique for Optimal Distribution of Available Stocks to Bases
- RM-1803 Base-depot Model Studies
- RM-1830 Air Force Provisioning Policies: An Analysis
- RM-1858 Relationships between Program Elements and System Demand for Airframe Spare Parts
- RM-1867 Design Change Impacts on Airframe Parts Inventories
- RM-1890 A Briefing on a Method of Estimating Spare Part Essentiality
- RM-1917-1 The Game Monopologs
- RM-1923 Production Characteristics of Hi-Valu Airframe Spare Parts
- RM-1962 Stockage Policies for Medium- and Low-cost Parts
- RM-2013 Electronic Data-processing Control of Air Force Spare-parts Inventories
- RM-2085 Savings from Procurement Deferral with Interim Contractor Support: The Case of High-value Airframe Spares
- RM-2088 A Priori Demand Prediction: A Case Study of B-52 Airframe Parts
- RM-2182 Costs of Procurement Deferral with Interim Contractor Support: Hi-Valu Airframe Spares
- RM-2233 Experimental Design, Test, and Evaluation of an F-100D Flyaway Kit
- RM-2235 Design-change History of F-100 Hi-Valu Airframe Spare Parts
- RM-2269 The Next Step in Air Force Centralization of Inventory Recordkeeping and Supply Data Processing
- RM-2365 Supply and Depot-repair Interactions: A Case Study of Electronics Support
- RM-2418 The Base Repair Cycle for the F-102 Fire Control System
- RM-2455 Misslogs: A Game of Missile Logistics
- RM-2536 The Use of Bayesian Techniques for Predicting Spare-parts Demand
- RM-2656 Base-depot Requisitioning Pipeline Times
- RM-2701 Application of the Bayes Technique to Spare-parts Demand Prediction
- RM-2702 An Examination of the Use of Statistical Aggregates To Improve Management Control of Large Organizations
- RM-2722 Decision Rules for the Disposal of Excess Air Force Stock
- RM-2767 Spare Parts Inventories for NATO
- P-611 The Costs of Alternative Air Base Stocking and Requisitioning Policies
- P-647 An Optimal Inventory Policy for a Military Organization
- P-748 A Fruitful Application of Static Marginal Analysis
- P-799 The Design of Military Supply Tables for Spare Parts
- P-910 A Min-Max Solution of an Inventory Problem
- P-1010 Continuous Production and Emergent Demand
- P-1055 Design Change Impacts on Airframe Parts Inventories
- P-1064 A Briefing on a Method of Estimating Spare Part Essentiality
- P-1068 A Proposal for Reducing the Cost of Logistics Support
- P-1220 Inventory Control: Exploiting the Electronic Data Processor in the Air Force
- P-1366 Interservice Supply Management within the Defense Department
- P-1376 A Method for Determining Supply Quantity for the Case of Poisson Distribution of Demand
- P-1586 Random Simulation of an Air Base Inventory Control System for a Repairable Part
- P-1689 The Use of Numerical Simulation in the Development of Inventory Policy

LOGISTICS—continued

SUPPLY—continued

- P-1725 Experimental Design, Test, and Evaluation of an F-100D Flyaway Kit
- P-1980 A Comparative Study of Prediction Techniques
- P-1981 Support Resources
- P-1996 Optimal Inventory Policy for Serviceable and Repairable Stocks
- P-2001 Toward a New System for Allocating the Cost of Capacity
- P-2207 Asymptotic Behavior of the Total Cost Function for Dynamic Inventory Processes
- P-2317 A Malfunction-generation Model for a Manned Simulation of ICBM Logistics
- P-2502 Some Statistical Properties of Selected Inventory Models
- P-2517 A Brief Review of Inventory Theory

TRANSPORTATION AND MOBILITY

- RA-15015 A Problem in Logistics: The Jeep Problem
- RA-15019 A Problem in Logistics: The Jeep Problem (Part 2)—App. IV to Fourth Quarterly Report, RA-15033
- RM-267 Illustrative Example of Application of Koopmans' Transportation Theory to Scheduling Military Tanker Fleet
- RM-406 Routing of Empties for Fixed-schedule Transportation
- RM-555 The Capacity of a Railroad Freight Yard (A Survey of the Problem—Not a Solution)
- RM-951 The Problem of Defining and Measuring Railroad Capacity
- RM-1380 Cargo Density and Air Transportation
- RM-1490 A Preferred Method for Designing a Flyaway Kit
- RM-1541 The Effectiveness of Alternative Flyaway Kits
- RM-1592 Steam Locomotive Availability and Terminal Facilities
- RM-1612 Allocating MATS Equipment with the Aid of Linear Programming
- RM-1658 The Allocation of MATS Airlift—January, 1956: Pacific Ocean Area
- RM-1853 Cargo Density and Airlift
- RM-2062 Experimental Design and Evaluation of an F-86H Flyaway Kit
- RM-2539 Vehicles for Exploration on Mars
- RM-2566 Aircraft Compartment Design Criteria for the Army Deployment Mission
- P-282 Efficient Transportation in Networks
- P-288 Transportation
- P-448 The Allocation of Switching Work in a System of Classification Yards
- P-724 Cargo Density Variations: A Challenge to Air Transport
- P-727 The Allocation of Aircraft to Routes: An Example of Linear Programming under Uncertain Demand
- P-734 Comments on Future Military Air Transport Requirements
- P-803 The Value of Airlift in Defensive, Local, or Peripheral Wars after 1960
- P-1138 Intercontinental Military Air Transport: An Application of a Model for the Study of Aircraft Procurement Policies
- P-1181 Efficient Transportation and Industrial Location
- P-1517 The Peacetime Use of Military Airlift
- P-1690 A Macro Analysis of Military Air Transportation
- P-1826 A Structural Approach to Military Air Transportation
- P-1828 Peak Loads and Efficient Pricing: A General Solution and a Practical Approach
- P-1882 A Model for Evaluating Fleets of Transport Aircraft
- P-2076 Compatibility of Military and Commercial Airlift Requirements
- P-2082 Aircraft Compartment Design Criteria for the Army Deployment Mission
- P-2489 The Journey-to-Work as a Determinant of Residential Location

MATHEMATICS—See also Game Theory, Language, Logistics, and Statistics

ADAPTIVE PROCESSES

- RM-2937-PR Optimal and Nearly Optimal Policies for a Class of Adaptive Control Processes
- P-1508 On the Concepts of a Problem and Problem-solving
- P-1573 Functional Equations in Adaptive Processes and Random Transmission

- P-1580 The Research Frontier
- P-1610 On Adaptive Control Processes
- P-1699 A Mathematical Theory of Adaptive Control Processes
- P-1809 Some Aspects of Adaptive Control Processes
- P-1948 On Control of Linear Systems with Time Lags
- P-1991 A Mathematical Formulation of Variational Processes of Adaptive Type
- P-2239 The Analysis of Some Essential Considerations in Program Design of Real-time Control Systems
- P-2328 Mathematical Aspects of Adaptive Control
- P-2400 Mathematical Model-making as an Adaptive Process

BIOLOGICAL AND MEDICAL STUDIES

- R-336-RC Research and the Ulcer Problem
- RM-794 Bacteria
- RM-2519 A Mathematical Model of the Human External Respiratory System
- RM-2907-RC A Mathematical Model of Drug Distribution and the Solution of Differential-difference Equations
- P-311 An Application of Markov Processes to the Study of the Epidemiology of Mental Disease
- P-1550-RC Some Mathematical Aspects of Chemotherapy—I: One-organ Models
- P-1560-RC The Distribution of a Drug in the Body
- P-1811 A Mathematical Model of the Human External Respiratory System
- P-1911 Some Mathematical Aspects of Optimal Predation in Ecology and Boviculture
- P-2013 On the Computational Solution of Differential-Difference Equations
- P-2044 Numerical Investigations of Chemotherapy Models
- P-2048 A Mathematical Model of the Chemistry of the External Respiratory System
- P-2102-RC Mathematical Models of Chemotherapy
- P-2139 Application of Mathematical Programming to Physiology: Human Respiratory System
- P-2154 New Version of a Two-organ Chemotherapy Model
- P-2191 Some Experiments and Problems in Mathematical Biology
- P-2300 Mathematical Experimentation and Biological Research
- P-2303 From Chemotherapy to Computers to Trajectories
- P-2307 Simulation of a Biological System on an Analog Computer
- P-2328 Mathematical Aspects of Adaptive Control
- P-2419 On the Reduction of Certain Multiplicative Chemical Equilibrium Systems to Mathematically Equivalent Additive Systems
- P-2565 Physicochemical Characteristics of Placental Transfer

CLASSICAL ANALYSIS

- RM-50 Tables of Integrals Associated with the Error Function of a Complex Variable
- RM-100 General Problem in the Calculus of Variations with Applications to Paths of Least Time
- RM-190 A Problem in Fourier Transforms Connected with the Design of an Antenna
- RM-880 On the Everywhere Denseness of a Certain Semigroup of Transformations
- RM-969 On a Class of Matrices with Known Characteristic Roots and Vectors
- RM-1978 Resolution of Real-coefficient Polynomials in Control System Analysis
- RM-2896-PR Widths and Heights of $(0, 1)$ -Matrices
- RM-2897-PR Multiplicities and Minimal Widths for $(0, 1)$ -Matrices
- RM-2898-PR Width Sequences for Special Classes of $(0, 1)$ -Matrices
- RM-3001-PR Poisson Summation Formulas for Groups—I: Finite Groups
- RM-3031-PR On a Mechanical Interpretation of the Null Geodesics in Static Einstein-Riemann Spaces
- RM-3039-PR On the Characterization of Contemporaneous and Born Rigid Motions and the Question of Their Equivalence
- RM-3092-PR Augmentation Analysis of the Einstein Gravitational Field
- P-73 Iterates of Fractional Order
- P-74 Some Applications of a Theorem on Convex Functions
- P-318 Nonnegative Square Matrices
- P-344 A Note on Primitive Matrices
- P-469 Notes on Matrix Theory—IV (An Inequality Due to Bergström)

MATHEMATICS—continued

CLASSICAL ANALYSIS—continued

- P-523 A Review of Fourier Analysis and Autocorrelation
- P-577 On an Iterative Procedure for Obtaining the Perron Root of a Positive Matrix
- P-594 Notes on Matrix Theory—VI
- P-635 Perturbation Methods in Applied Mathematics
- P-715 Notes on Matrix Theory—IX
- P-716 On a Generalization of Some Integral Identities Due to Ingham and Siegel
- P-736 Balance Scale Sorting
- P-755 Notes on Matrix Theory—X: A Problem in Control
- P-772 Limit Theorems for Noncommutative Processes—II: On a Generalization on the Stieltjes Integral
- P-786 On Schlicht Functions with Real Coefficients
- P-903 On a Class of Functional Equations of Modular Type
- P-938 On the Expansions of Some Infinite Products
- P-947 On Positive Definite Matrices and Stieltjes Integrals
- P-1018 Notes on Matrix Theory—XIV: On the Jacobi Relation for the Bracket Symbol
- P-1065 On the Non-negativity of Green's Functions
- P-1095 Notes on Matrix Theory—XV: Multiplicative Inequalities Obtained from Additive Inequalities
- P-1097 Kronecker Products and the Second Method of Lyapunov
- P-1115 A Linear Diophantine Problem
- P-1152 On the Estimation of the Kloosterman Sum
- P-1164 The Existence of Conservation Laws—I
- P-1245 Primes in the Thousandth Million
- P-1404 On the Rank of a Certain Set of Equations
- P-1618 Zero-One Matrices with Zero Trace
- P-1722 The Dirichlet Functional
- P-1728 The Existence of Conservation Laws—II
- P-1755 On the Rationalization of Certain Complex Elliptic Integrals
- P-1792 Widths and Heights of $(0, 1)$ -Matrices
- P-1804 Dynamic Programming and Classical Analysis
- P-1831 The Rational Points on a Transcendental Curve
- P-1922 Traces, Term Ranks, Widths and Heights
- P-2040 On the Elementary Approach to Diophantine Equations
- P-2043 The Computational Solution of Variational Problems
- P-2085 The Representation of Planar Graphs by Convex Polyhedra
- P-2158 The Analysis and Solution of Optimum Trajectory Problems
- P-2200 Some Numerical Experiments Using Newton's Method for Nonlinear Parabolic and Elliptic Boundary-value Problems
- P-2251 On Variation-diminishing Properties of Green's Functions
- P-2272 Multiplicities and Minimal Widths for $(0, 1)$ -Matrices
- P-2294-2 A New Upper Bound for Error Correcting Codes
- P-2334 A New Approach to the Duality Theory of Mathematical Programming
- P-2348 A q -Version of the Newton Interpolation Formula and Some Eulerian Identities
- P-2368-1 On the Continuation of Orthogonal Structure across a Surface of Discontinuity in the Momentum-energy Tensor
- P-2369 Discontinuities in the Einstein-field for General Momentum-energy Tensors
- P-2391 On an Invariant Characterization of Momentum-energy Tensors for Generalized Media
- P-2411 Differential Compatibility Conditions on the Momentum-energy Tensor and Necessary Conditions for the Existence of Solutions to the Einstein Field Equations
- P-2460 Statistics on the First Six Million Prime Numbers
- P-2500 A Short Table of Prime Numbers

COMPUTING MACHINES

- RM-226 Principles of the REAC
- RM-227 Photoelectric Coverage Machine

- RM-236 Summary of REAC Experience
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-317 Application of the Photoelectric Machine: Expected Damage by a Single Weapon
- RM-525 RAND REAC Manual
- RM-594 The Combomat—Customer-programmed IBM Calculation
- RM-596 Matrix Multiplication Using Standard IBM Equipment
- RM-657 Use of the Special Program Device on the 417 Tabulator
- RM-1044 The Duplex System for IBM's Model II CPC: A Fast Four-address, Double-operation, Floating-decimal Setup
- RM-1251 The D.P.F.D.: A Double Precision (18 Digits) Floating Decimal Setup for IBM's Model II CPC
- RM-1361 Parallel Control
- RM-1754 A Revised Data-processing System for Managing War Reserve Stocks of Aircraft Spare Parts
- RM-2415 The Flight Operations Planner
- RM-2525 Addendum to RM-2415, *The Flight Operations Planner*
- RM-2541 Soviet Computer Technology—1959
- RM-2799-PR Soviet Cybernetics and Computer Sciences, 1960
- RM-2859-PR New Directions of Research in the Theory of Differential Equations
- RM-3007-PR Studies in the Theory of Computational Algorithms—1: Formalization, Computability, Representation, and Analysis Problems
- RM-3011 Mechanisms Underlying Predictive Behavior for an Intelligent Machine
- RM-3083-PR Some Questions concerning Difference Approximations to Partial Differential Equations
- P-197 Modifications of the RAND REAC
- P-199 Optimum Trajectories
- P-216 The Combomat
- P-356 A Survey of Automatic Computers: Analog and Digital
- P-363 RAND's Digital Computer Effort
- P-374 Permanent Setups for IBM Calculators
- P-377 The History and Development of the Electronic Computer Project at the Institute for Advanced Study
- P-384 Conductive Plastics in Analog Computing
- P-416 The EIP: An External and Internal Program Setup for IBM's Model II CPC
- P-417 Matrix Inversion on an Automatic Calculator by Row and Column Partitioning
- P-434 Computers Unlimited: Digital Machines in Tomorrow's Business World
- P-482 Computational Experience in Solving Linear Programming Problems
- P-505 A Note Concerning the Organization of an IBM Type 701 Installation
- P-509 Applications of a Cathode Ray Tube Readout Device for the IBM 701 Electronic Data Processing Machine
- P-608 The Digital Computer: Where Does It Go from Here?
- P-620 The Chess Machine: An Example of Dealing with a Complex Task by Adaptation
- P-686 Description of a Cooperative Venture in Production of an Automatic Coding System
- P-688 Computing Experience with Linear Programming and Its Variants
- P-691 File Reference
- P-692 PACT Loop Expansion
- P-693 Semi-automatic Allocation of Data Storage for PACT I
- P-719 Conclusions after Using the PACT-1 Advanced Coding Technique
- P-759 An Automatic Supervisor for the IBM 702
- P-857-AD PACT-1A
- P-868 The Logic Theory Machine: A Complex Information Processing System
- P-900 Evolution of Linear Programming Computing Techniques
- P-951 Empirical Explorations of the Logic Theory Machine: A Case Study in Heuristics
- P-954 Programming the Logic Theory Machine
- P-966 An Experiment in Symbolic Work on the IBM 704
- P-969 SHARE: A Eulogy to Cooperative Effort
- P-971 Elements of a Theory of Human Problem Solving

MATHEMATICS—continued

COMPUTING MACHINES—continued

- P-987 Problem Solving in Humans and Computers
- P-1008 Reliability and the Computer
- P-1124 Comparison of American Rotary Electric Desk Calculators
- P-1145 *Digital Computer Programming: A Book Review*
- P-1230 Contrasts in Large File Memories for Large-scale Computers
- P-1273 Programming and Modification in the SHARE 709 System
- P-1277 A Command Structure for Complex Information Processing
- P-1319 Chess-playing Programs and the Problem of Complexity
- P-1320 The Processes of Creative Thinking
- P-1356 On "Heuristic Problem Solving" by Simon and Newell
- P-1599 A Short History of Digital Computing in Southern California
- P-1635 Some Aspects of a Personnel Program for Computer Programmers
- P-1708 What Have Computers To Do with Management?
- P-1742 A Variety of Intelligent Learning in a General Problem Solver
- P-1751 Computing and Education
- P-1752 A Technique for Handling Macro Instructions
- P-1799 Summary of a Heuristic Line Balancing Procedure
- P-1815 Continuous Programming Methods on an Analog Computer
- P-1817 An Information Processing Theory of Verbal Learning
- P-1820 An Experiment in Chess Playing by Machine
- P-1900 Linguistic Research at The RAND Corporation
- P-1924-RC The Potential of Electronic Data Processing in Municipal Government
- P-1929 An Introduction to Information Processing Language V
- P-1932 Sixty Years of Growth in Computing and Data-processing Capability
- P-1946 On Programming a Highly Parallel Machine To Be an Intelligent Technician
- P-1961-RC Long-range Considerations in Data Processing for State and Local Governments
- P-1989 A Digital Simulation of an Aided Adaptive Character Reading Machine
- P-1990 An Aided Adaptive Character Reader for Machine Translation of Languages
- P-1993 A Heuristic Program for Assembly-line Balancing
- P-2050 An Example of Man-Machine Simulation in Logistics Research
- P-2062-RC The Future of Data Processing in State Government
- P-2094 Successive Approximations and Computer Storage Problems
- P-2097 The Use of Protocols in Programming Research
- P-2102-RC Mathematical Models of Chemotherapy
- P-2114-1 Attitudes toward Intelligent Machines
- P-2116-1 Introduction to Sequential Circuits
- P-2127 The Use of Heuristic Programming in Management Science
- P-2142 New Areas of Application of Computers
- P-2158 The Analysis and Solution of Optimum Trajectory Problems
- P-2170 Toward Intelligent Machines
- P-2221 Modeling Human Mental Processes
- P-2235 The Simulation of Verbal Learning Behavior
- P-2257 GPS: A Program That Simulates Human Thought
- P-2258 Why We Cannot Build "Thinking Machines" (At Least at Present)
- P-2264-1 Some Suggested Techniques for Data System Development
- P-2276 Computer Simulation of Human Thinking
- P-2307 Simulation of a Biological System on an Analog Computer
- P-2311 Forgetting in an Association Memory
- P-2312 Computer Simulation of Human Thinking and Problem Solving
- P-2358 Performance of a Reading Task by an Elementary Perceiving and Memorizing Program
- P-2362 An Algorithm for Scaling Matrices
- P-2375 A Theory of the Serial Position Effect
- P-2437 Development of a Business Language
- P-2447 Systematic Methods for Programming Simplification

- P-2449 Operations Useful for Similarity-invariant Pattern Recognition
- P-2452 Possible Economies through Electronic Data Processing
- P-2454 Can EDP Be Applied to All Police Agencies?
- P-2457 Beginner's FORTRAN
- P-2483 Secondary Schools and Computing
- P-2492 Data Processing for Cities
- P-2552 A One-day Look at Computing
- P-2557 A Data Processing System for State and Local Governments
- T-124 Excerpts on the Ural-I and Ural-II Soviet Digital Computers
- T-133 A Specialized Digital Computer and an Experiment in Its Use (A Computer with Reduced Capabilities)
- T-134 Electronic Digital Machines and Programming
- T-135 Electronic Computers in the Service of the National Economy
- T-137 A Computer Capable of Learning
- T-146 Digital Computers in the Soviet Union

CONTROL PROCESSES

- R-313 Some Aspects of the Mathematical Theory of Control Processes
- R-350 Adaptive Control Processes: A Guided Tour
- RM-2859-PR New Directions of Research in the Theory of Differential Equations
- RM-2937-PR Optimal and Nearly Optimal Policies for a Class of Adaptive Control Processes
- P-1610 On Adaptive Control Processes
- P-1691 The Mathematical Theory of Control Processes
- P-1798 Some Optimization Problems in Chemical Engineering
- P-1802 Directions of Mathematical Research in Nonlinear Circuit Theory
- P-1809 Some Aspects of Adaptive Control Processes
- P-1948 On Control of Linear Systems with Time Lags
- P-1964 Reduction of Dimensionality, Dynamic Programming, and Control Processes
- P-1991 A Mathematical Formulation of Variational Processes of Adaptive Type
- P-2130 Dynamic Programming, Fermat's Principle, and the Eikonal Equation
- P-2187 An Optimum Thrust Control Problem
- P-2210 Computational Considerations for Some Deterministic and Adaptive Control Processes
- P-2239 The Analysis of Some Essential Considerations in Program Design of Real-time Control Systems
- P-2241 Interrupted Stochastic Control Processes
- P-2319 Some Limitations of Automatic Test Equipment
- P-2328 Mathematical Aspects of Adaptive Control
- P-2402 A Computational Procedure for Optimal Control Problems with State Variable Constraint
- P-2450 Partially Controllable Random Walk

DIFFERENTIAL EQUATIONS

- R-256 A Survey of the Mathematical Theory of Time-lag, Retarded Control, and Hereditary Processes
- RM-688 A Bibliography of the Theory and Application of Differential-difference, Renewal, and Related Functional Equations
- RM-1973 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- RM-2318 A Note on the Numerical Integration of Nonlinear Partial Differential Equations
- RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
- RM-2859-PR New Directions of Research in the Theory of Differential Equations
- RM-2891-PR On the Numerical Solution of a Differential-Difference Equation Arising in Analytic Number Theory
- RM-2924-PR Some Aspects of Quasilinearization
- RM-3083-PR Some Questions concerning Difference Approximations to Partial Differential Equations
- RM-3113-PR Some Numerical Results Using Quasilinearization for Nonlinear Two-point Boundary Value Problems

MATHEMATICS—continued

DIFFERENTIAL EQUATIONS—continued

- RM-3122-PR On Asymptotic Behavior of Solutions of Second-order Differential Equations
 - P-121 Theory of Blind Navigation by Dynamical Measurements
- P-244 Linear Approximations in a Class of Nonlinear Vector Differential Equations
- P-381 The Stability Theory of Differential-difference Equations
- P-439 Note on the Numerical Treatment of Second-order Differential Equations
- P-463 On Perturbation Methods Involving Expansions in Terms of a Parameter
- P-465 On the Crank-Nicolson Procedure for Solving Parabolic Partial Differential Equations
- P-475 Equilibrium Analysis: The Stability Theory of Poincaré-Liapounoff and Extensions
- P-499 On the Convergence of a Procedure of DuFort and Frankel for the Numerical Solution of Parabolic Partial Differential Equations
- P-500 A Note on the Relativistic Thomas-Fermi Atom Model
- P-552 On the "Bang-Bang" Control Problem
- P-645 Radiation Patterns of Unsymmetrically Fed Prolate Spheroidal Antennas
- P-731 A New Technique for Eigenvalue Problems—I
- P-956 On the Linear Differential Equation Whose Solutions Are the Products of Solutions of Two Given Linear Differential Equations
- P-960 Hydrodynamical Stability and Poincaré-Lyapunov Theory—I
- P-1012 A Note on Monotone Convergence to Solutions of First-order Differential Equations
- P-1082 On the Determination of Characteristic Values for a Class of Sturm-Liouville Problems
- P-1125 On the Representation of the Solution of a Class of Stochastic Differential Equations
- P-1153 On the Non-negativity of Solutions of the Heat Equation
- P-1163 On Nonlinear Differential Equations, the Maximum Operation, and Monotone Convergence
- P-1226 On the Computational Determination of the Nature of Solutions of Nonlinear Systems with Stochastic Inputs
- P-1239 Invariant Imbedding, Wave Propagation, and the WKB Approximation
- P-1252 Invariant Imbedding and Neutron Transport Theory—II: Functional Equations
- P-1260 On Convergent Perturbation Expansions
- P-1271 On a Generalization of a Result of Wintner
- P-1280 Stability Theory and Adjoint Operators for Linear Differential-Difference Equations
- P-1316 Asymptotic Series for the Solutions of Linear Differential-Difference Equations
- P-1422 Semi-groups of Class (C_0) in L_p Determined by Parabolic Differential Equations
- P-1440 On a Liouville Transformation for $u_{xx} + u_{yy} \pm a^2(x, y)u = 0$
- P-1470 Asymptotic Behavior of Solutions of Differential-Difference Equations
- P-1663 On the Limit of Solutions of Differential-Difference Equations as the Retardation Approaches Zero
- P-1700 Invariant Imbedding and Neutron Transport in a Rod of Changing Length
- P-1709 SPADE: A Set of Subroutines for Solving Elliptic and Parabolic Partial Differential Equations
- P-1781 On the Increase of Convergence Rates of Relaxation Procedures for Elliptic Partial Difference Equations
- P-1812 On a Phase Method for Treating Sturm-Liouville Equations and Problems
- P-1870 Asymptotic Behavior of Solutions of Linear Parabolic Equations
- P-1930 Perturbation and Renormalization—I
- P-1952 Dissipation Functions and Invariant Imbedding—I
- P-2013 On the Computational Solution of Differential-Difference Equations
- P-2044 Numerical Investigations of Chemotherapy Models
- P-2094 Successive Approximations and Computer Storage Problems
- P-2154 New Version of a Two-organ Chemotherapy Model
- P-2182 On the Iterative Solution of Two-point Boundary Value Problems
- P-2190 A Note on an Inverse Problem in Mathematical Physics
- P-2200 Some Numerical Experiments Using Newton's Method for Nonlinear Parabolic and Elliptic Boundary-value Problems
- P-2210 Computational Considerations for Some Deterministic and Adaptive Control Processes

- P-2233 On the Computational Solution of a Class of Nonlinear Differential-Difference Equations
- P-2297 Linear Differential Systems with Periodic Coefficients Involving a Large Parameter
- P-2309 Renormalization Techniques and Mean Square Averaging—I: Deterministic Equations
- P-2335 Self-consistent Solutions of Deterministic and Stochastic Nonlinear Differential Equations
- P-2343-1 Equations of Perturbed Motion for Low-eccentricity Orbits
- P-2361 A Note on Perturbation Series
- P-2393 On the Asymptotic Behavior of Solutions of Nonlinear Differential Equations
- P-2536 On the Output Probability Density Function of a Linear Device with Certain Non-gaussian Random Inputs
- T-51 On the Spectrum of Singular Boundary-value Problems for Elliptic Differential Equations
- T-125 The Solution of Linear Differential Equations by the Method of the Complete Differential

DYNAMIC PROGRAMMING

- R-245 An Introduction to the Theory of Dynamic Programming
- R-271 Dynamic Programming of Continuous Processes
- R-295 Dynamic Programming
- R-313 Some Aspects of the Mathematical Theory of Control Processes
- R-350 Adaptive Control Processes: A Guided Tour
- RM-647 On a General Class of Problems Involving Sequential Analysis
- RM-677 The Determination of Decision Regions for a Simplified Two-plane Bombing Model
- RM-684 Decision Functions for Bombing Models
- RM-859 Some Functional Equations Related to Dynamic Programming Problems Involving Noncommutative Operations
- RM-895 On Some Variational Problems Occurring in Dynamic-programming Theory—I
- RM-933 Decision Processes and Functional Equations
- RM-949 Some Simple Nonlinear Models
- RM-971 Duality in Dynamic Programming
- RM-972 On Some Variational Problems Occurring in the Theory of Dynamic Programming—II
- RM-973 On Some Variational Problems Occurring in the Theory of Dynamic Programming—III
- RM-978 On Some Variational Problems Occurring in the Theory of Dynamic Programming—IV
- RM-980 On Some Variational Problems Occurring in the Theory of Dynamic Programming—V
- RM-994 On Some Variational Problems Occurring in the Theory of Dynamic Programming—VI
- △ RM-1045 A Stockpiling Problem: Mathematical Treatment
- RM-1069 On an Application of the Theory of Dynamic Programming to Bottleneck Problems in Production and Allocation
- RM-1087 A Problem in Programming Steel Production and Its Solution by Differential Game Theory
- RM-1102 A Production-line Assignment Problem
- △ RM-1125 On Continuous Versions of Dynamic-programming Problems—III: Two Interdependent Industries with No Capacity Constraints
- RM-1126 On Continuous Versions of Dynamic-programming Problems—IV: Duality Theorems for Bottleneck Problems
- RM-1241 On the Limiting Behavior of Discrete Dynamic-programming Processes—I (The Gold-mining Problem)
- RM-1242 On the Limiting Behavior of Discrete Dynamic-programming Processes—II (A Direct Proof of Convergence)
- RM-1243 On the Limiting Behavior of Discrete Dynamic-programming Processes—III (The Generalized Gold-mining Problem)

MATHEMATICS—continued

DYNAMIC PROGRAMMING—continued

- RM-1336 On the Computational Solution of Some Functional Equations in the Theory of Dynamic Programming
- RM-1341 On the Solution of an Approximate Equation in the Theory of Optimal Allocation
- RM-1368 On the Convergence of Discrete Stochastic Decision Processes to Their Continuous Analogues
- RM-1379 Optimization in Dynamic Allocation Problems by a Modified Calculus of Variations Technique
- RM-1386 On the Continuous Simplex Method
- RM-1414 On the Convergence of Discrete Stochastic Decision Processes to Their Continuous Analogues—II
- RM-1430 A Resource Allocation Problem in Continuous Form
- RM-1501 Discrete Approximations to Some Continuous Dynamic-programming Processes
- RM-1652 Optimal Sequential Testing
- RM-1710 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
 - RM-1741 On the Optimal Use of Guided Missiles—I: Allocation of Missiles
 - RM-1742 On the Optimal Use of Guided Missiles—II: Dummy Missiles
- RM-1745 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel
- RM-1746 On the Computational Solution of Dynamic-programming Processes—II: On a Cargo-loading Problem
- RM-1747 On the Computational Solution of Dynamic-programming Processes—III: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Expected Damage
- RM-1748 On the Computational Solution of Dynamic-programming Processes—IV: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Probability of Success
- RM-1749 On the Computational Solution of Dynamic-programming Processes—V: A Smoothing Problem
- RM-1750 Computational Solutions of Dynamic-programming Processes—VI: On the Optimal-trajectory Problem
- RM-1751 On the Computational Solution of Dynamic-programming Processes—VII: Radar Nets
- RM-1752 On the Computational Solution of Dynamic-programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- RM-1859 Notes on Linear Programming—Part XXXIX: Slightly Intertwined Linear Programming Matrices
- RM-1888 On the Formulation of Dynamic-programming Problems—I
- RM-1889 On the Computational Solution of Dynamic-programming Processes—X: The Fly-away-kit Problem
 - RM-1898 On the Formulation of Dynamic-programming Processes—IV: On the Allocation of Bombers and Decoys
- RM-1901 On the Computational Solution of Dynamic-programming Processes—IX: A Multi-stage Logistic-procurement Model
- RM-1904 Dynamic Programming and Stochastic Control Processes
- RM-2134 On the Computational Solution of Dynamic-programming Processes—XV: An Industrial Replacement Process
- RM-2189 Some Applications of Dynamic Programming to Communication and Information Theory
- RM-2245 On the Computational Solution of Dynamic-programming Processes—XVI: Reliability of Multicomponent Devices
- RM-2279 An Optimal-inventory Model
- RM-2282 On the Computational Solution of Dynamic-programming Processes—XIV: Missile-allocation Problems

- RM-2288 Invariant Imbedding and Wave Propagation in Stochastic Media
- RM-2319 On the Computational Solution of Dynamic Programming Processes—XI: A Feed-back-control Problem
- RM-2354 On the Application of Dynamic Programming to a Class of Implicit Variational Problems
 - RM-2396 On Control of Reactor Shutdown Involving Minimal Xenon Poisoning
- RM-2471 A Preliminary-design Aid for Studying Component Weight Assignments in Ballistic-missile Payloads
- RM-2514 Search Rules for Automatic Fault Location
- RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
- RM-2888-PR Variational Methods in Problems of Control and Programming
- RM-2978-PR On the Approximation of Curves by Line Segments Using Dynamic Programming—II
- RM-3063-PR Functional Equations in the Theory of Dynamic Programming—XII: An Application of the Maximum Transform
- RM-3084-PR Polynomial Approximation: A New Computational Technique in Dynamic Programming—I: Allocation Processes
 - RAOP-37 Bayes and Minimax Solutions of Sequential Decision Problems
- P-230 On Some Dynamic Linear Programming Problems
 - P-328 A Bayes Model in Sequential Design
- P-329 On a Functional Equation Occurring in the Theory of Dynamic Programming
- P-341 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-380 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-382 Studies in Functional Equations Occurring in Decision Processes
- P-398 On Limit Theorems for Noncommutative Operations—I
 - P-402 Optimal Two- and Three-stage Production Schedules with Setup Times Included
 - P-407 Bottleneck Problems and Dynamic Programming
 - P-410 Some Functional Equations in the Theory of Dynamic Programming
- P-423 Computational Problems in the Theory of Dynamic Programming
- P-433 A Functional Equation in the Theory of Dynamic Programming and Its Generalizations
 - P-436 On the Continuous Gold-mining Equation
 - P-454 Dynamic Programming and a New Formalism in the Calculus of Variations
 - P-455 Some Problems in the Theory of Dynamic Programming
- P-456 Some Combinatorial Problems Arising in the Theory of Multistage Processes
- P-457 On Some Applications of the Theory of Dynamic Programming to Logistics
- △ P-480 On a Functional Equation Arising in the Problem of Optimal Inventory.
 - P-483 Bottleneck Problems, Functional Equations, and Dynamic Programming
- P-486 A General Survey of the Theory of Dynamic Programming
 - P-490 Some Applications of the Theory of Dynamic Programming
- P-491 The Theory of Dynamic Programming as Applied to a Smoothing Problem
- P-492 Studies on Bottleneck Problems in Production Processes
- △ P-495 Dynamic Programming and the Calculus of Variations—I
 - P-513 Monotone Convergence in Dynamic Programming and the Calculus of Variations
 - P-550 The Theory of Dynamic Programming
- P-566 Some Functional Equations in the Theory of Dynamic Programming—I: Functions of Points and Point Transformations
 - P-568 Decisionmaking in the Face of Uncertainty—I: Uncertain Outcome
 - P-572 On the Optimal Inventory Equation
 - P-574 Dynamic Programming and a New Formalism in the Theory of Integral Equations
- P-575 On a Quasi-linear Equation
 - P-580 On the Optimal Inventory Equation
 - P-586 A Problem in the Sequential Design of Experiments
 - P-589 Dynamic Programming and Multistage Decision Processes of Stochastic Type
 - P-593 Decisionmaking in the Face of Uncertainty—II
 - P-597 Dynamic Programming and a New Formalism in the Calculus of Variations—I
- P-631 Notes in the Theory of Dynamic Programming—II: A Functional Equation Arising in Allocation Theory

MATHEMATICS—continued

DYNAMIC PROGRAMMING—continued

- P-632 Notes in the Theory of Dynamic Programming—III: Equipment Replacement Policy
- P-634 A Stockpiling Problem: Mathematical Treatment
- P-640 Notes in the Theory of Dynamic Programming—IV: A Variational Problem with Constraints
- P-651 Mathematical Aspects of Scheduling Theory
- P-671 Functional Equations in the Theory of Dynamic Programming—II: Nonlinear Differential Equations
- P-676 Functional Equations in the Theory of Dynamic Programming—III: Multistage Games
- P-696 Some Aspects of the Theory of Dynamic Programming
- P-702 On a New Class of Functional Equations in Analysis
- P-703 On the Computational Solution of Some Large-scale Dynamic-programming Processes
- P-704 Functional Equations in the Theory of Dynamic Programming—V: Positivity and Quasi-linearity
- P-705 Functional Equations in the Theory of Dynamic Programming—IV: Multistage Decision Processes of Continuous Type
- P-714 On a Class of Variational Problems
- P-718 The Problem of Continuous Programs
- P-721 Notes on the Theory of Dynamic Programming—V: Maximization over Discrete Sets
- P-764 Functional Equations in the Theory of Dynamic Programming—VI: A Direct Convergence Proof
- P-765 Notes on Control Processes—I: On the Minimum of Maximum Deviation
- P-771 Notes on the Theory of Dynamic Programming—VII: Transportation Models
- P-773 Notes on the Theory of Dynamic Programming—VI: The Warehousing Model
- P-780 Dynamic Programming and the Numerical Solution of Variational Problems
- P-783 An Abstract Setting for the Notion of Dynamic Programming
- P-784 Eigenvalues and Functional Equations
- P-787 Dynamic Programming
- P-796 Dynamic Programming and Its Application to Variational Problems in Mathematical Economics
- P-807 On the Application of the Theory of Dynamic Programming to the Study of Control Processes
- P-834 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
- P-837 Multidimensional Maximization, Dynamic Programming, and Economic Lot Size
- P-845 Notes on the Theory of Dynamic Programming—VIII
- P-859 Functional Equations in the Theory of Dynamic Programming—VII: An Integro-differential Equation for the Fredholm Resolvent
- P-866 On a Dynamic Programming Approach to the Caterer Problem—I
- P-869 Dynamic Programming and Lagrange Multipliers
- P-885 A Comparison of Linear Programming and Dynamic Programming
- P-917 On Some Applications of Dynamic Programming to Matrix Theory
- P-918 Notes on Matrix Theory—XIII: Slightly Intertwined Linear Programming Matrices
- P-924 Computational Aspects of Dynamic Programming
- P-932 An Analytic Solution of the Warehouse Problem
- P-949 On the Role of Dynamic Programming in Statistical Communication Theory
- P-964 General Systems Approaches to Telecommunication Optimization Problems
- P-977 A Dynamic Programming Solution to a Cascading Problem Arising in Heavy Water Production
- P-1000 On a Routing Problem
- P-1003 Dynamic Programming and Stochastic Control Processes
- P-1038 Dynamic Programming and the Variational Solution of the Thomas-Fermi Equation
- P-1039 A Generalized Equipment Replacement Study
- P-1045 A Note on an Industrial Replacement Process
- P-1072 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel

- P-1081 Functional Equations in the Theory of Dynamic Programming—VIII: The Variation of Green's Functions—One-dimensional Case
- P-1083 Dynamic Programming Solution of Allocation Problems
- P-1086 Multi-dimensional Maximization and Dynamic Programming
- P-1101 Terminal Control, Time-lags, and Dynamic Programming
- P-1133 Dynamic Programming, Nonlinear Variational Processes, and Successive Approximations
- P-1139 Dynamic Programming and the Reliability of Multicomponent Devices
- P-1147 Dynamic Programming and Mean Square Deviation
- P-1148 Some New Techniques in the Dynamic-programming Solution of Variational Problems
- P-1150 Dynamic Programming and the Variation of Green's Functions
- P-1155 Dynamic Programming and the Computational Solution of Feedback Design Control Problems
- P-1175 Dynamic Programming, Successive Approximations, and Variational Problems of Combinatorial Nature
- P-1176 Functional Approximations and Dynamic Programming
- P-1194 On Communication Processes Involving Learning and Random Duration
- P-1223 On Weighted PCM and Mean Square Deviation
- P-1227 Dynamic-programming Approach to Optimal Inventory Processes with Delay in Delivery
- P-1228 The Utility of a Communication Channel and Applications to Suboptimal Information-handling Procedures
- P-1232 A Note on Preventative Sampling
- P-1239 Invariant Imbedding, Wave Propagation, and the WKB Approximation
- P-1252 Invariant Imbedding and Neutron Transport Theory—II: Functional Equations
- P-1282 On the Computational Solution of Dynamic Programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- P-1284 Combinatorial Processes and Dynamic Programming
- P-1325 On Some Communication Network Problems
- P-1331 Functional Equations in the Theory of Dynamic Programming—IX: Variational Analysis, Analytic Continuation, and Imbedding of Operators
- P-1332 Functional Equations in the Theory of Dynamic Programming—X: Resolvents, Characteristic Functions, and Values
- P-1333 Approximation in Policy Space, Linear, and Nonlinear Programming
- P-1369 Introduction to Dynamic Programming
- P-1374 On the Application of Dynamic Programming to a Class of Implicit Variational Problems
- P-1416 Dynamic Programming and Adaptive Processes—I: Mathematical Foundation
- P-1417 On k th Best Policies
- P-1463 An Application of Dynamic Programming to the Determination of Optimal Satellite Trajectories
- P-1464 Dynamic Programming and the Calculus of Variations
- P-1471 Invariant Imbedding and Wave Propagation in Stochastic Media
- P-1494 Functional Equations and Maximum Range
- P-1500 On Control of Reactor Shut-down Involving Minimal Xenon Poisoning
- P-1515 On the Foundations of Dynamic Programming
- P-1527 Dynamic-programming Algorithms and Formulations
- P-1529 Functional Equations, Wave Propagation, and Invariant Imbedding
- P-1551 On an Application of Dynamic Programming to the Synthesis of Logical Systems
- P-1597 Sequential Machines, Ambiguity, and Dynamic Programming
- P-1613 Dynamic Programming, Invariant Imbedding, and Two-point Boundary Value Problems
- P-1614 Invariant Imbedding, Random Walk, and Scattering—II: Discrete Versions
- P-1627 Approximation Techniques in Dynamic Programming
- P-1665 A Discussion of Several Concepts Used in the Optimization of Control Systems by Dynamic Programming
- P-1699 A Mathematical Theory of Adaptive Control Processes
- P-1700 Invariant Imbedding and Neutron Transport in a Rod of Changing Length

MATHEMATICS—continued

DYNAMIC PROGRAMMING—continued

- P-1766 What Is Dynamic Programming?
- P-1778 Dynamic Programming and Feedback Control
- P-1804 Dynamic Programming and Classical Analysis
- P-1809 Some Aspects of Adaptive Control Processes
- P-1839 Ballistic-missile Payload Allocation
- P-1843 Functional Equations in the Theory of Dynamic Programming—XI: Limit Theorems
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1903 On the Foundations of a Theory of Stochastic Variational Processes
- P-1906 Dynamic Programming and Gaussian Elimination
- P-1911 Some Mathematical Aspects of Optimal Predation in Ecology and Boviculture
- P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
- P-1948 On Control of Linear Systems with Time Lags
- P-1964 Reduction of Dimensionality, Dynamic Programming, and Control Processes
- P-1973 Dynamic Programming, Sequential Estimation, and Sequential Detection Processes
- P-1991 A Mathematical Formulation of Variational Processes of Adaptive Type
- P-2011 Some Mathematical Aspects of Optimization Problems in Engineering
- P-2083 Functional Equations in the Theory of Dynamic Programming—XII: Complex Operators and Min-Max Variation
- P-2104 The Reciprocity Formula for Multidimensional Theta Functions
- P-2128 Perspectives of Dynamic Programming
- P-2130 Dynamic Programming, Fermat's Principle, and the Eikonal Equation
- P-2145 On Various Versions of the Defective Coin Problem
- P-2158 The Analysis and Solution of Optimum Trajectory Problems
- P-2177-1 The Optimization of Multi-stage Orbit Transfer Processes by Dynamic Programming
- P-2207 Asymptotic Behavior of the Total Cost Function for Dynamic Inventory Processes
- P-2210 Computational Considerations for Some Deterministic and Adaptive Control Processes
- P-2225 On the Approximation of Curves by Line Segments Using Dynamic Programming
- P-2237 Dynamic Programming Treatment of the Traveling Salesman Problem
- P-2241 Interrupted Stochastic Control Processes
- P-2243 On the Reduction of Dimensionality for Classes of Dynamic Programming Processes
- P-2260 How Useful Are "Scientific" Tools of Management?
- P-2284 Dynamic Programming and "Difficult Crossing" Puzzles
- P-2306 Variational Methods in Problems of Control and Programming
- P-2308 Dynamic Programming and Linear Prediction Theory
- P-2324 Dynamic Programming and the Variational Principles of Classical and Statistical Mechanics
- P-2328 Mathematical Aspects of Adaptive Control
- P-2357 Variational Problems with Inequality Constraints
- P-2374 The Numerical Solution of Variational Problems
- P-2392-1 On Some Mathematical Recreations
- P-2394 Design of Minimal Weight Structures for Given Reliability and Cost
- P-2427 Finite Nets—II: Uniqueness and Imbedding

EXTREMUM PROBLEMS

- RM-618 A Simple Maximization Problem
- RM-909 Some Results in Nonlinear Programming
- RM-935 Some Results in Nonlinear Programming—Part II
- RM-1318 On the Minimization of $\int_0^T |I - x(t)| dt$
- RM-1379 Optimization in Dynamic Allocation Problems by a Modified Calculus of Variations Technique
- RM-1409 On Maximizing an Inner Product
- RM-1438 The Optimization of Quadratic Functions Subject to Linear Constraints
- RM-1529 Relative Maxima in Variational Problems with Inequality Constraints
- RM-1590 Best Exploration for Maximum Is Fibonacci

- RM-1603 A Search Problem Due to Bellman
- RM-3056-PR On the Maximum Transform and Semigroups of Transformations
- RM-3063-PR Functional Equations in the Theory of Dynamic Programming—XII: An Application of the Maximum Transform
 - P-636 Some Nonclassical Problems in the Calculus of Variations
 - P-637 The Optimization of a Quadratic Function Subject to Linear Constraints
 - P-639 Variational Problems with Constraints
 - P-706 Reduction of Constrained Maxima to Saddle-point Problems
 - P-821 On Explicit Solutions of Some Trinomial Equations in Terms of the Maximum Operation
 - P-856 Best Exploration for Maximum Is Fibonacci
 - P-876 Discrete Variable Extremum Problems
 - P-928 Gradient Methods for Constrained Maxima
- P-1822 Some Special Search Problems
 - P-2010 Accelerating the Cutting Plane Method for Nonlinear Programming
 - P-2028 A Duality Theorem for Nonlinear Programming
 - P-2181 The Present Status of Nonlinear Programming
 - P-2189 Quasilinearization and Upper and Lower Bounds for Variational Problems
 - P-2320 On a New Functional Transform in Analysis: The Maximum Transform
 - P-2328 Mathematical Aspects of Adaptive Control
- T-86 On Methods of Analysis of Some Extremal Problems in Planning Production

FUNCTIONAL REPRESENTATION

- RM-15 The Location of the Maximum of a Function of Two Independent Variables When the Dependent and Independent Variables Are Measured without Error
- RM-16 Maximizing $Z = Z(X, Y)$ When Z Is Known Exactly Only for Certain Values of One or Both Independent Variables
 - RM-24 R-7.2 Maximization of a Function $\varphi(XY)$
 - RM-59 Representation by Sums of Separable Functions
 - RM-76 Least-squares Approximations by Sums of Separable Functions
 - RM-83 Representation by Sums of Separable Functions in n Dimensions
 - RM-98 Note on a Functional Form for Polynomials
 - RM-164 On a Minimum Problem
- RM-176 Some Notes on the Slide-rule Problem
- RM-183 A Slide-rule Inequality
- RM-450 On Functions of the Form $\sum_{i=1}^n \varphi_i(x)\psi_i(y)$
- RM-499 On Measurable Functions K Which Satisfy $K(x+y) = \sum_{v=1}^n \varphi_v(x)\psi_v(y)$
- P-323 Polynomial-like Approximation
 - P-1232 A Note on Preventative Sampling
- P-1529 Functional Equations, Wave Propagation, and Invariant Imbedding
- P-2163 On the Fundamental Equations of Invariant Imbedding—I
- P-2338 The Quantification of Functional Load

INEQUALITIES

- RM-156 Some Elementary Inequalities
- RM-2883-PR On Systems of Linear Inequalities in Hermitian Matrix Variables
- P-211 Remark on the Minkowski Inequality
 - P-212 Dresher's Inequality
 - P-252 Moment Spaces and Inequalities
- P-412 Inequalities
- P-598 On a General Method in the Theory of Inequalities
 - P-770 On Converses of Schwarz's Inequality
 - P-1207 On Inequalities for Differential Operators
- P-1233 On a Differential Inequality of Cesari and Turner
 - P-1361 Representation Theorems and Inequalities for Hermitian Matrices
- P-1418 Bounds on the Expectation of a Convex Function of a Multivariate Random Variable
- P-1512 On Inequalities with Alternating Signs

MATHEMATICS—continued

INTEGRAL EQUATIONS

- R-277 Equations of State on the Thomas-Fermi Statistical Model
- RM-363 A Class of Integral Equations
- RM-372 Asymptotic Solutions for a Class of Integral Equations and Their Application to Neutron Transmission through a Finite Slab
- RM-446 On the Number of Eigenvalues of a Certain Symmetric Kernel
- RM-686 A Stochastic Development of "Ballantyne's Integral Equation"
- RM-1973 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- P-130 A Class of Integral Equations
- P-158 Expectations, Positive Transformations, and Tauberian Theorems
- P-173 On the Integral Equation $\lambda f(x) = \int_0^a e^{-(x-y)^2} f(y) dy$
- P-233 A Note on a Class of Integral Equations Related to the Bessel and Mathieu Functions
- P-322 A Random Walk Related to the Capacitance of the Circular-plate Condenser
- P-338 On Maximizing an Integral with a Side Condition
- P-429 On the Distribution of Certain Functionals of Markoff Processes
- P-544 Asymptotic Solutions for a Class of Integral Equations
- P-574 Dynamic Programming and a New Formalism in the Theory of Integral Equations
- P-730 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena—II: Examples
- P-1084 On the Variation of the Fredholm Resolvent

LEARNING THEORY

- RM-921 A Mathematical Treatment of Learning Models
- P-108 An Airframe Production Function
- P-267 Use of the Learning Curve
- P-345 The Influence of Environmental Nonstationarity in a Sequential Decision-making Experiment
- P-346 On Game-learning Theory and Some Decision-making Experiments
- P-353 On Stochastic Learning Theory
- P-382 Studies in Functional Equations Occurring in Decision Processes
- P-1194 On Communication Processes Involving Learning and Random Duration
- P-1584 Report on a General Problem-solving Program
- P-2328 Mathematical Aspects of Adaptive Control

LINEAR PROGRAMMING

- R-351 The RAND Symposium on Mathematical Programming: Linear Programming and Recent Extensions—Proceedings of a Conference, March 16–20, 1959
- RM-1019 Comments on J. von Neumann's *The Problem of Optimal Assignment in a Two-person Game*
- △ RM-1096 On a New Iterative Algorithm for Finding the Solutions of Games and Linear-Programming Problems
- RM-1140 Algebraic Solution of Linear-programming Problems
- RM-1264 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
- RM-1265 Notes on Linear Programming—Part II: Duality Theorems
- RM-1266 Notes on Linear Programming—Part III: Computational Algorithm of the Revised Simplex Method
- RM-1267-1 Notes on Linear Programming—Part IV: Constructive Proof of the Minmax Theorem
- RM-1268 Notes on Linear Programming—Part V: Alternate Algorithm for the Revised Simplex Method Using a Product Form for the Inverse
- RM-1268A Notes on Linear Programming—Part V: A Product-form Tableau for Revised Simplex Method—Computing Appendix for RM-1268

- RM-1269 Notes on Linear Programming—Part VI: The RAND Code for the Simplex Method
- RM-1270 Notes on Linear Programming—Part VII: The Dual Simplex Algorithm
- RM-1274 Notes on Linear Programming—Part XI: Composite Simplex–Dual Simplex Algorithm—I
- RM-1275 Notes on Linear Programming—Part XII: A Composite Simplex Algorithm—II
- RM-1281 Notes on Linear Programming—Part XIII: Optimal Solution of a Dynamic Leontief Model with Substitution
- RM-1290 Notes on Linear Programming—Part XIV: A Computational Procedure for a Scheduling Problem of Edie
- RM-1328 Notes on Linear Programming—Part XV: Minimizing the Number of Carriers To Meet a Fixed Schedule
- RM-1367 Notes on Linear Programming—Parts VIII, IX, and X: Upper Bounds, Secondary Constraints, and Block Triangularity in Linear Programming
- RM-1369 Notes on Linear Programming—Part XVI: The Problem of Routing Aircraft—A Mathematical Solution
- RM-1374 Notes on Linear Programming—Part XVII: Linear Programming under Uncertainty
- RM-1375 Notes on Linear Programming—Part XVIII: Status of Solution of Large-scale Linear-programming Problems
- RM-1383 Notes on Linear Programming—Part XIX: The Fixed-charge Problem
- RM-1386 On the Continuous Simplex Method
- RM-1400 Notes on Linear Programming—Part XX: Maximal Flow through a Network
- RM-1418 Notes on Linear Programming—Part XXI: On the Max Flow Min Cut Theorem of Networks
- RM-1432 Notes on Linear Programming—Part XXIII: A Production Smoothing Problem
- RM-1433 Background, Development, and Extensions of the Revised Simplex Method
- RM-1440 Notes on Linear Programming—Part VI: The RAND Code for the Simplex Method (SX4) (For the IBM 701 Electronic Computer)
- RM-1452 Notes on Linear Programming—Part XXV: The Elimination Form of the Inverse and Its Application to Linear Programming
- RM-1470 Notes on Linear Programming—Part XXIV: The Modification of the Right-hand Side of a Linear Programming Problem
- RM-1475 Notes on Linear Programming—Part XXII: Recent Advances in Linear Programming
- RM-1489 Notes on Linear Programming—Part XXVI: Computation of Maximal Flows in Networks
- RM-1521 Some Experiments on the Traveling-salesman Problem
- RM-1553 Notes on Linear Programming—Part XXVII: Dilworth's Theorem on Partially Ordered Sets
- RM-1560 Notes on Linear Programming—Part XXVIII: A Simple Linear-programming Problem Explicitly Solvable in Integers
- RM-1604 Notes on Linear Programming—Part XXIX: A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem
- RM-1644 Notes on Linear Programming—Part XXX: A Class of Discrete-type Minimization Problems
- RM-1687 Communication Networks—I: Optimal Design and Utilization
- RM-1688 Communication Networks—II: Interoffice Trunking Problems
- RM-1709 Notes on Linear Programming—Part XXXI: A Primal-Dual Algorithm
- RM-1736 Notes on Linear Programming—Part XXXII: Solving the Transportation Problem
- RM-1737 Notes on Linear Programming—Part XXXIII: A Theorem on Flows in Networks
- RM-1739 Some Observations on the Maximization on Stieltjes Integrals
- RM-1757 A Linear Programming Model of the U.S. Petroleum Refining Industry
- RM-1785 Costs and Benefits in Mathematical Programming
- RM-1798 Notes on Linear Programming—Part XXXIV: A Primal-Dual Algorithm for the Capacitated Hitchcock Problem
- RM-1799 Notes on Linear Programming—Part XXXVII: Concerning Multicommodity Networks
- RM-1832 Notes on Linear Programming—Part XXXV: Discrete-variable Extremum Problems

MATHEMATICS—continued

LINEAR PROGRAMMING—continued

- RM-1833 Notes on Linear Programming—Part XXXVI: The Allocation of Aircraft to Routes—An Example of Linear Programming under Uncertain Demand
- RM-1859 Notes on Linear Programming—Part XXXIX: Slightly Intertwined Linear Programming Matrices
- RM-1864 Notes on Linear Programming—Part XXXVIII: Note on B. Klein's "Direct Use of Extremal Principles in Solving Certain Problems Involving Inequalities"
- RM-1976 Notes on Linear Programming—Part XLIII: A Feasibility Algorithm for One-way Substitution in Process Analysis
- RM-1977 Notes on Linear Programming—Part XL: Network Flow and Systems of Representatives
- RM-1981 Notes on Linear Programming—Part XLI: Constructing Maximal Dynamic Flows from Static Flows
- RM-2021 Notes on Linear Programming—Part XLII: Linear Programming and Structural Design
- RM-2152 Notes on Linear Programming—Part XLIV: Transient Flows in Networks
- RM-2159 Notes on Linear Programming—Part XLV: A Network-flow Feasibility Theorem and Combinatorial Applications
- RM-2178 Notes on Linear Programming—Part XLVI: Bounds on the Primal-Dual Computation for Transportation Problems
- RM-2209 Notes on Linear Programming—Part XLVII: Solving Linear Programs in Integers
- RM-2240 Complements and Substitutes in the Optimal Assignment Problem
- RM-2287 Notes on Linear Programming—Part XLVIII: Inequalities for Stochastic Linear Programming Problems
- RM-2321 On a Linear-Programming-Combinatorial Approach to the Traveling-salesman Problem: Notes on Linear Programming and Extensions—Part 49
- RM-2338 On Network Flow Functions: Notes on Linear Programming and Extensions—Part 50
- RM-2388 The Simplex Method for Quadratic Programming: Notes on Linear Programming and Extensions—Part 51
- RM-2425 Computing Tetraethyl-lead Requirements in the Linear-Programming Format: Notes on Linear Programming and Extensions—Part 52
- RM-2480 On the Equivalence of the Capacity-constrained Transshipment Problem and the Hitchcock Problem: Notes on Linear Programming and Extensions—Part 53
- RM-2597 An Algorithm for the Mixed Integer Problem: Notes on Linear Programming and Extensions—Part 54
- RM-2751 On the Solution of Two-stage Linear Programs under Uncertainty: Notes on Linear Programming and Extensions—Part 55
- RM-2752 Methods of Solution of Linear Programs under Uncertainty: Notes on Linear Programming and Extensions—Part 56
- RM-2813-PR The Decomposition Algorithm for Linear Programming: Notes on Linear Programming and Extensions—Part 57
- RM-2883-PR On Systems of Linear Inequalities in Hermitian Matrix Variables
- RM-2956-PR An Algorithm for Scaling Matrices: Notes on Linear Programming and Extensions—Part 58
- RM-2957-PR Linear Programming in a Markov Chain: Notes on Linear Programming and Extensions—Part 59
- RM-2993-PR A Linear Program of Prager's: Notes on Linear Programming and Extensions—Part 60
- P-392 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
- P-435 Comments on J. von Neumann's *The Problem of Optimal Assignment in a Two-person Game*
- P-440 The Product Form for the Inverse in the Simplex Method
- △ ● P-461 Interrelations between Linear Programming and Game Theory
- P-468 Notes on Parametric Linear Programming

- P-473 On a New Iterative Algorithm for Finding the Solutions of Games and Linear Programming Problems
- P-482 Computational Experience in Solving Linear Programming Problems
 - P-510 Solution of a Large-scale Traveling-salesman Problem
- P-533 Air Cargo Transport Scheduling: An Illustrative Block Triangular System
 - P-561 The Problem of Routing Aircraft: A Mathematical Solution
- P-562 Revisions and Extensions to the Simplex Method (With Sidelights on Programming Techniques)
 - P-563 A Linear Programming Model of the U.S. Petroleum Refining Industry
- P-564 Constructive Proof of the Min-Max Theorem
 - P-569 Notes on Linear Programming—Part XV: Minimizing the Number of Carriers To Meet a Fixed Schedule
- P-576 Upper Bounds, Secondary Constraints, and Block Triangularity in Linear Programming
- P-596 Linear Programming under Uncertainty
- P-602 Concepts and Computing Procedures for Certain X_{ij} Programming Problems
- P-609 A Linear-programming Solution to Dynamic Leontief Type Models
 - P-610 A Production Smoothing Problem
- P-648 The Fixed Charge Problem
- P-651 Mathematical Aspects of Scheduling Theory
- P-652 Recent Advances in Linear Programming
- P-677 Computation of Maximal Flows in Networks
 - P-680 The Elimination Form of the Inverse and Its Application to Linear Programming
- P-685 Linear Programming and Economic Theory
- P-688 Computing Experience with Linear Programming and Its Variants
- P-711 On the Solution of Discrete Programming Problems
 - P-727 The Allocation of Aircraft to Routes: An Example of Linear Programming under Uncertain Demand
- P-735 On the Partition of the Vertices of an n -Cube by an $(n - 1)$ -Plane
 - P-763 Note on B. Klein's *Direct Use of Extremal Principles in Solving Certain Problems Involving Inequalities*
- P-778 A Primal-Dual Algorithm
- P-810 Evolution of Computer Codes for Linear Programming
 - P-824 Thoughts on Linear Programming and Automation
 - P-826 On the Max Flow Min Cut Theorem of Networks
 - P-842 Manual for the RAND-IBM Code for Linear Programming on the 704
 - P-844 Optimal Utilization and Extension of Interoffice Trunking Facilities
 - P-876 Discrete Variable Extremum Problems
- P-885 A Comparison of Linear Programming and Dynamic Programming
- P-891 The Simplex Method
- P-892 The Central Mathematical Problem
- P-893 Formulating a Linear Programming Model
 - P-907 The Storage Allocation of the Linear Programming Code
 - P-908 Adaptability of the Linear Programming Codes
 - P-909 Operating the Linear Programming Codes
 - P-911 The Revised Simplex Method
 - P-914 Preparation of Input for the Linear Programming Code
 - P-916 The Complete Dualized System of the Simplex Method
 - P-921 Upper Bounded Variables in Linear Programming
 - P-925 Printing and Checking for Linear Programming Codes
 - P-936 Costs and Benefits in Mathematical Programming
 - P-950 Linear Programming
- P-964 General Systems Approaches To Telecommunication Optimization Problems
- P-980 Concepts, Origins, and Use of Linear Programming
- P-1015 On Gradient Methods for Approaching Constrained Maxima
- P-1028 On the Status of Multistage Linear Programming Problems
 - P-1029 Dynamic Programming: Methods and Application
 - P-1059 Chemical Equilibrium in Complex Mixtures
 - P-1060 A Linear-programming Approach to the Chemical Equilibrium Problem

MATHEMATICS—continued

LINEAR PROGRAMMING—continued

- P-1122 Linear Programming and Structural Design—I: Limit Analysis
- P-1123 Linear Programming and Structural Design—II: Limit Design
- P-1205 The Simplex Method for Quadratic Programming
- P-1206 Optimum Linear Estimation for Random Processes as the Limit of Estimates Based on Sampled Data
- P-1231 A Linear Programming Model of the Gaseous-diffusion Isotope-separation Process
- P-1281 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem
- P-1325 On Some Communication Network Problems
- P-1333 Approximation in Policy Space, Linear, and Nonlinear Programming
- P-1359 Solving Linear Programs in Integers
- P-1410 On Integer and Partial Integer Linear Programming Problems
- P-1448 An Equivalent Linear-programming Problem
- P-1459 Solving Two-move Games with Perfect Information
- P-1486 On the Significance of Solving Linear-programming Problems with Some Integer Variables
- P-1490 The Cross-section Method: An Algorithm for Linear Programming
- P-1532 The Dual of a Transportation Problem Is Not a Transportation Problem
- P-1544 A Decomposition Principle for Linear Programs
- P-1545 Computing Tetraethyl Lead Requirements in the Linear Programming Format
- P-1596 Some Results and Problems in Stochastic Linear Programming
- P-1600 Inequalities for Stochastic Linear-programming Problems
- P-1630 The Bottleneck Assignment Problem
- P-1643 Functional Equations and Successive Approximations in Linear and Nonlinear Programming
- P-1646 New Directions in Mathematical Programming
- P-1664 General Convex Objective Forms
- P-1723 Machine Analysis Methods for Network Vulnerability Problems
- P-1842 Linear Programming in a Markov Chain
- P-1851 Inductive Proof of the Simplex Method
- P-1885 An Algorithm for the Mixed-integer Problem
- P-1899 The Separation of Uranium Isotopes by Gaseous Diffusion: A Linear-programming Model
- P-1939 Use of the "Expected Value Solution" in Linear Programming under Uncertainty
- P-1947 A Network Flow Computation for Project Cost Curves
- P-1948 On Control of Linear Systems with Time Lags
- P-2039 On the Solution of Two-stage Linear Programs under Uncertainty
- P-2056 Solving the Chemical Equilibrium Problem Using the Decomposition Principle
- P-2132 Methods of Solution of Linear Programs under Uncertainty
- P-2184 Complements and Substitutes in the Optimal Assignment Problem
- P-2185 On Network Flow Functions
- P-2240 College Admissions and the Stability of Marriage
- P-2260 How Useful Are "Scientific" Tools of Management?
- P-2363 An Algorithm for Scaling Matrices
- P-2373 An Extended Composite Algorithm for Linear Programming
- P-2404-1 The Use of Quadratic Programming in Stochastic Linear Programming
- P-2405 The Simplex Method Using Pseudo-basic Variables for Structured Linear Programming Problems
- P-2514 Linear Programming

LINEAR SPACES

- RM-697 An Embedding of a Mixture Space in a Vector Space
- RM-698 An Embedding of a Utility Space in an Ordered Vector Space
- RM-712 Separation Theorems for Convex Bodies
- P-271 Ordered Vector Spaces

- P-588 Fully Convex Normed Linear Spaces
- T-19 Elementary Theory of Convex Polyhedrons
- T-22 The Theory of Linear Inequalities

MISCELLANEOUS

- R-109 A Decision Method for Elementary Algebra and Geometry
- RM-103 On the Number of Preference Arrangements of n Objects
- RM-617 What Is a Sensitivity Analysis?
- RM-651 On a Problem in the Theory of Testing
- RM-950 List of Unclassified Mathematics Division Publications, Including Related Reports from Other Divisions
- RM-1370 Functional Equations, Wiener Integrals, and Applications—I: Functional Equations
- RM-1504 The Maximization of an Integral Subject to Constraints
- RM-1860 Solution of a Ranking Problem from Binary Comparisons
- RM-1861 An Industrial-location Planning Problem
- RM-2259 On the Growth of Duty Cycle in Intermittent Communication Systems
- RM-2273 A Problem in Spectrum Estimation
- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-2887-PR Minimum-weight Design for Moving Loads
- RM-2906-PR Operators Commuting with Translation by One—Part II: Differential Operators with Periodic Coefficients
- RM-2917-PR Estimates of Critical Dimensions of Spherical and Slab Reactors
- RM-3007-PR Studies in the Theory of Computational Algorithms—I: Formalization, Computability, Representation, and Analysis Problems
- P-385 Some Mathematical Methods and Techniques in Economics
- P-398 On Limit Theorems for Noncommutative Operations—I
- P-403 Effects of Surface Tension and Viscosity on Taylor Instability
- △ ● P-485 On Limit Theorems for Noncommutative Operations—II: A Generalization of a Result of Koenig
- P-678 Čech Compactifications of Products
- P-698 The Topology of Finitary Approximation
- P-712 A Theorem on Description Adequacy
- P-713 A Note on the Dynamics of a Disordered Linear Chain
- P-722 Families of Transformations in the Function Spaces H^p
- P-744 Degrees of Computability
- P-877 Solution of a Ranking Problem from Binary Comparisons
- P-941 A Feasibility Algorithm for One-way Substitution in Process Analysis
- P-1070 A Cyclic Arrangement of n -Tuples
- P-1090 *Topological Dynamics*: A Book Review
- P-1215 A Tournament Problem
- P-1363 Aggregation of Utility Functions
- P-1451 Isobars and Antipodes
- P-1484 A General Theorem Concerning the Stability of a Particular Non-Newtonian Fluid
- P-1503 Operators Commuting with Translation by One
- P-1508 On the Concepts of a Problem and Problem-solving
- P-1510 Simultaneous Equations and Canonical Correlation Theory
- P-1521 Reliability Estimating by the Use of Random Sampling Simulation
- P-1525 *Calculus of Variations and Its Applications*: A Book Review
- P-1526 Sequencing n Jobs on Two Machines with Arbitrary Time Lags: Alternate Proof and Discussion of General Case
- P-1581 Simulation and Stimulation
- P-1630 The Bottleneck Assignment Problem
- P-1638 The Application of Random Sampling Simulation to Reliability Estimating
- P-1653 Functional Equations and Theta-functions—I
- P-1723 Machine Analysis Methods for Network Vulnerability Problems

MATHEMATICS—continued

MISCELLANEOUS—continued

- P-1785 Printed Circuits, Graphs, Manifolds
- P-1853 The Use of Reliability Estimates in the Design of Missile Prelaunch Checkout Equipment
- P-1867 How Much Automaticity for Checkout Equipment
- P-1966 An Ergodic Theorem
- P-2081-2 The Imbedding of Graphs in Manifolds
- P-2102-RC Mathematical Models of Chemotherapy
- P-2151 Optimal Sequencing of Serial Memory Transfers
- P-2159 Preferential Arrangements
- P-2232 Operators Commuting with Translation by One—Part I: Representation Theorems
- P-2233 On the Computational Solution of a Class of Nonlinear Differential-Difference Equations
- P-2253-1 Estimates of Critical Dimensions of Spherical and Slab Reactors
- P-2260 How Useful Are "Scientific" Tools of Management?
- P-2299-1 Hierarchic Algebra
- P-2377-1 Path-invariant Comma-free Codes
- P-2398 Minimal Imbeddings and the Genus of a Graph
- P-2400 Mathematical Model-making as an Adaptive Process
- P-2426 Simplest Imbeddings of the Complete 12 Graph
- P-2427 Finite Nets—II: Uniqueness and Imbedding
- P-2428 Remarks on the Genus of a Complete Graph
- P-2450 Partially Controllable Random Walk
- P-2495 Decisions, Communication, and Organization
- P-2531 The Maximum Connectivity of a Graph
- P-2534 A Complementary Problem on Nonplanar Graphs
- P-2545-1 The Null Set of the Euler-Lagrange Operator
- T-48 On the Cauchy Problem for Nonlinear Equations in a Class of Discontinuous Functions
- T-92 Theory and Applications of the Notion of Complex Signal

MOMENT SPACES

- RM-534 Moment-space Boundaries and Some Applications
- P-97 Geometry of Reduced Moment Spaces
- P-159 On the General Moment Problem
- P-227 Geometry of Moment Spaces
- P-252 Moment Spaces and Inequalities
- P-982 Bounds on the Expectations of a Convex Function of a Random Variable
- P-1418 Bounds on the Expectation of a Convex Function of a Multivariate Random Variable

NUMERICAL ANALYSIS

- R-264 Approximations for Digital Computers
- R-277 Equations of State on the Thomas-Fermi Statistical Model
- R-351 The RAND Symposium on Mathematical Programming: Linear Programming and Recent Extensions—Proceedings of a Conference, March 16–20, 1959
- RM-50 Tables of Integrals Associated with the Error Functions of a Complex Variable
- RM-102 Numerical Methods of Obtaining Solutions of Fixed End-point Problems in the Calculus of Variations
- RM-123 An Integral Arising in Vulnerability Studies
- RM-151 Empirical Analysis: Exponential Series
- RM-187 Mechanical Inversion of the Laplace Transform
- RM-194 Empirical Analysis: Power Series
- RM-242 Successive Approximation
- RM-339 Table of Q Functions
- RM-482 The Evaluation of a Definite Integral
- RM-490 Lagrangian Interpolation Coefficients and the Calculation of Maxima and Minima and Points of Inflection

- RM-595 Machine Methods: Iterative Solution of Games
- RM-596 Matrix Multiplication Using Standard IBM Equipment
- RM-644 Extracting Roots of Polynomial Equations
- RM-660 Tables in Brief: Mathematical Tables for Use with Desk Calculators
- RM-859 Some Functional Equations Related to Dynamic Programming Problems Involving Noncommutative Operations
- RM-1433 Background, Development, and Extensions of the Revised Simplex Method
- RM-1978 Resolution of Real-coefficient Polynomials in Control System Analysis
- RM-2132 Additive Generation of Pseudorandom Numbers
- RM-2318 A Note on the Numerical Integration of Nonlinear Partial Differential Equations
- RM-3007-PR Studies in the Theory of Computational Algorithms—1: Formalization, Computability, Representation, and Analysis Problems
- RM-3084-PR Polynomial Approximation: A New Computational Technique in Dynamic Programming—I: Allocation Processes
- RAOP-31 A Note on the Numerical Problem of Matrix Inversion
- P-78 Some Notes on Computation of Games Solutions
 - P-114 Rational Approximation in High-speed Computing
 - P-216 The Combomat
 - P-314 The RAND Collection of Illustrative Approximations
- P-317 Analytical Approximations
 - P-330 Analytical Approximations, Volume II
 - P-340 Analytical Approximations, Volume III
 - P-348 Analytical Approximations, Volume IV
 - P-355 Analytical Approximations, Volume V
 - P-358 Analytical Approximations, Volume VI
 - P-364 Analytical Approximations, Volume VII
- P-374 Permanent Setups for IBM Calculators
 - P-376 Analytical Approximations, Volume VIII
 - P-387 Analytical Approximations, Volume IX
 - P-397 Analytical Approximations, Volume X
 - P-404 The Incomplete Approximator (In Six Fits)
 - P-415 Analytical Approximations, Volume XI
- P-417 Matrix Inversion on an Automatic Calculator by Row and Column Partitioning
 - P-424 Approximations in Numerical Analysis: A Report on a Study
 - P-426 Analytical Approximations, Volume XII
 - P-441 Analytical Approximations, Volume XIII
 - P-452 Numerical Solution of a Spherical Blast Wave
 - P-499 On the Convergence of a Procedure of DuFort and Frankel for the Numerical Solution of Parabolic Partial Differential Equations
 - P-505 A Note Concerning the Organization of an IBM Type 701 Installation
 - P-515 Analytical Approximations, Volume XIV
 - P-541 A Note on Plastic Torsion
 - P-555 Analytical Approximations, Volume XV
 - P-559 Analytical Approximations, Volume XVI
- P-562 Revisions and Extensions to the Simplex Method (With Side Lights on Programming Techniques)
- P-578 Machine Testing for Deviation of Data from a Poisson Distribution
 - P-592 Analytical Approximations, Volume XVII
 - P-595 Analytical Approximations, Volume XVIII
 - P-601 Analytical Approximations, Volume XIX
 - P-607 Analytical Approximations, Volume XX
 - P-911 The Revised Simplex Method
 - P-916 The Complete Dualized System of the Simplex Method
 - P-932 An Analytic Solution of the Warehouse Problem
- P-935 Sequential Minimax Search for a Zero of a Convex Function
- P-948 A Unified Process for the Evaluation of the Zeros of Polynomials over the Complex Number Field
 - P-1033 Analytical Approximations, Volume XXI

MATHEMATICS—continued

NUMERICAL ANALYSIS—continued

- P-1067 A Note on the Numerical Integration of a Class of Nonlinear Hyperbolic Differential Equations
- P-1098 Analytical Approximations, Volume XXII
- P-1117 Analytical Approximations, Volume XXIII
- P-1163 On Nonlinear Differential Equations, the Maximum Operation, and Monotone Convergence
- P-1184 Analytical Approximations, Volume XXIV
- P-1205 The Simplex Method for Quadratic Programming
- P-1208 Analytical Approximations, Volume XXV
- P-1213 On Initial Estimates for Computing $a^{1/p}$ by Newton's Method
- P-1217 Analytical Approximations, Volume XXVI
- P-1229 Analytical Approximations, Volume XXVII
- P-1245 Primes in the Thousandth Million
- P-1301 Analytical Approximations, Volume XXVIII
- P-1444 A Table for Obtaining Trial Values for Estimating Relationships in Which the Dependent Variable Is Limited
- P-1485 Multiple Quadrature by Monte Carlo
- P-1584 Report on a General Problem-solving Program
- P-1599 A Short History of Digital Computing in Southern California
- P-1627 Approximation Techniques in Dynamic Programming
- P-1667 The Secant Method for Simultaneous Nonlinear Equations
- P-1709 SPADE: A Set of Subroutines for Solving Elliptic and Parabolic Partial Differential Equations
- P-1723 Machine Analysis Methods for Network Vulnerability Problems
- P-1752 A Technique for Handling Macro Instructions
- P-1781 On the Increase of Convergence Rates of Relaxation Procedures for Elliptic Partial Difference Equations
- P-1846 On the Separation of Exponentials
- P-2063 Recent Developments in Nonlinear Programming—Part I
- P-2152 The Irrationality of the Zeros of the Bessel Functions, J_0 and J_1
- P-2210 Computational Considerations for Some Deterministic and Adaptive Control Processes
- P-2328 Mathematical Aspects of Adaptive Control
- P-2333-1 Recent Developments in Nonlinear Programming—Part II
- P-2446 Some Simplex-like Nonlinear Programming Procedures
- P-2460 Statistics on the First Six Million Prime Numbers
- P-2500 A Short Table of Prime Numbers

POLYNOMIALS AND SPECIAL FUNCTIONS

- RM-86 A Note on the Sums of Powers of the Roots of a Polynomial
- RM-196 A Theorem on Parametric Boolean Functions
- RM-199 Commutative Boolean Functions
- RM-856-1 Proof of a Theorem of Hayes on the Location of the Roots of a Certain Entire Transcendental Function
- RM-1880 Graphs of Partial Sums of the Binomial Distribution
- RM-1978 Resolution of Real-coefficient Polynomials in Control System Analysis
- P-90 Tables of Hermite Polynomials and the Derivations of the Error Function
- P-175 On Approximate Expressions for the Exponential Integral and the Error Function
- P-225 On the Iteration of Power Series in Two Variables
- P-247 Definite and Semidefinite Quadratic Equations
- P-323 Polynomial-like Approximation
- P-2079 Mie Scattering with Complex Index of Refraction
- RAT-7 Approximation of Empirical Functions of Discrete Distribution by Discontinuous Orthogonal Polynomials

PROBABILITY

- R-350 Adaptive Control Processes: A Guided Tour
- RM-134 An Approximate Solution for a Coverage Problem
- RM-184 An Apparent Ambiguity in the Interpretation of Minimum Risk
- RM-195 The Problem of Cunningham and Hynd
- RM-252 Composite Targets: n Identical Elements
- RM-289 Occurrence of Improbable States in a Modified Ehrenfest Model—Part I
- RM-309 A Circular Probability Grid
- RM-321 Occurrence of Improbable States in a Modified Ehrenfest Model—Part II
- RM-330 The Circular Coverage Function
- RM-357 On Positive Transformations
- RM-448 The Survival Probability Problem
- RM-522 Curves Giving Expected Results of a Bombing Strike
- RM-894 A Characterization of the Normal Distribution
- RM-900 Quantitative Theory of Human Behavior: The Single Individual
- RM-1237-AEC Applications of Monte Carlo
- RM-1570 The Prediction of Sequences
- RM-2124 A Comparison of Random and Periodic Data Sampling for the Detection of Signals in Noise
- RM-2149 Monte Carlo Models for Estimating Reliability: An Exploratory Analysis
- RM-2317 On One-dimensional Neutron Multiplication
- RM-2693 Neutron Branching Processes
- RM-2765-PR Some Characteristics of the Elliptic Gaussian Distribution
- RM-2869-PR Limiting Distributions for Critical Multitype Branching Processes with Discrete Time
- RM-2957-PR Linear Programming in a Markov Chain: Notes on Linear Programming and Extensions—Part 59
- RM-3090-PR Interpolation and Extrapolation of Stationary Random Sequences
- RM-3091-PR On the Structure of Stationary Random Functions
- RAOP-14 Branching Processes
- RAOP-38 On the Theory of Age-dependent Stochastic Branching Processes
- P-132 Modification of the Monte Carlo Method
- P-141 Recurrence Times for the Ehrenfest Model
- P-152 Some Mathematical Models for Branching Processes
- P-238 The First Passage Problem for a Continuous Markoff Process
- P-590 A Note on the Mean Value of Random Determinants
- P-728 The Existence of Stationary Measures for Certain Markov Processes
- P-738 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- P-767 Transient Markov Chains with Stationary Measures
- P-777 On a Generalization of the Fundamental Identity of Wald
- P-846 Priority Assignment on a Waiting Line
- P-863 Birth-Death Processes and Tandem Queues
- P-939 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena—III: Examples
- P-995 Queueing with Balking
- P-1020 The Random Functions of Cosmic-ray Cascades
- P-1066 A Markovian Decision Process
- P-1113 Random Walk, Scattering, and Invariant Imbedding—I: One-dimensional Discrete Case
- P-1132 The Casino That Takes a Percentage and What You Can Do About It
- P-1163 On Nonlinear Differential Equations, the Maximum Operation, and Monotone Convergence
- P-1165 Monte Carlo
- P-1201 Sequential Decision Problems with a Limited Memory
- P-1379 Consensus of Subjective Probabilities: The Pari-mutuel Method
- P-1485 Multiple Quadrature by Monte Carlo
- P-1563 A Mathematical Model for Multiplication by Binary Fission
- P-1614 Invariant Imbedding, Random Walk, and Scattering—II: Discrete Versions

MATHEMATICS—continued

PROBABILITY—continued

- P-1642 A Comparison of Random and Periodic Data Sampling for the Detection of Signals in Noise
- P-1666 A Lower Bound for the Critical Probability in a Certain Percolation Process
- P-1673 Recurrent Events in a Bernoulli Sequence
- P-1842 Linear Programming in a Markov Chain
- P-1858 Invariant Imbedding and Mathematical Physics—I: Particle Processes
- P-1985 Neutron Branching Processes
- P-1989 A Digital Simulation of an Aided Adaptive Character Reading Machine
- P-1990 An Aided Adaptive Character Reader for Machine Translation of Languages
- P-2067 Synchronization of Coherent Detectors
- P-2092 Statistical Methods in Markov Chains
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
- P-2186 The Compression of Finite Discrete Messages
- P-2202 Invariant Imbedding and Random Walk
- P-2207 Asymptotic Behavior of the Total Cost Function for Dynamic Inventory Processes
- P-2210 Computational Considerations for Some Deterministic and Adaptive Control Processes
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- P-2305 Limiting Distributions for Critical Multitype Branching Processes
- P-2407 Probability and Statistics in Systems Work
- P-2536 On the Output Probability Density Function of a Linear Device with Certain Non-gaussian Random Inputs
- P-2541 On the Optimality of Sequential Probability Ratio Tests
- RAT-11 Number of Rounds Required and Destruction Probability in Form of Tables and Graphs
- T-14 Collection of Articles on the Theory of Firing
- T-67 On a Local Limit Theorem for Inhomogeneous Markov Chains
- T-75 An Asymptotic Expansion for Inhomogeneous Markov Chains
- T-102 On the Probability of an n -Coincidence
- T-129 On the Spectral Theory of Stochastic Processes
- T-131 On Linear Methods in Probability Theory

TRANSPORTATION PROBLEMS AND NETWORK THEORY

- RA-15015 A Problem in Logistics: The Jeep Problem
- RA-15019 A Problem in Logistics: The Jeep Problem (Part 2)—App. IV to Fourth Quarterly Report, RA-15033
- RM-224 A Mathematical Model of an Air Transportation System
- RM-303 On the Hamiltonian Game (A Traveling-salesman Problem)
- RM-406 Routing of Empties for Fixed-schedule Transportation
- RM-648 On a Transportation Problem
- RM-1296 Consistency Problems in the Military Supply System
- RM-1400 Notes on Linear Programming—Part XX: Maximal Flow through a Network
- RM-1418 Notes on Linear Programming—Part XXI: On the Max Flow Min Cut Theorem of Networks
- RM-1489 Notes on Linear Programming—Part XXVI: Computation of Maximal Flows in Networks
- RM-1498 On Network Theory
- RM-1532 Determination of the Maximal Steady-state Flow of Traffic through a Railroad Network
- RM-1548 The Number of Distinct Cuts in a Network
- RM-1660 Min-Max Theorems on Shortest Chains and Disjunct Cuts of a Network
- RM-1688 Communication Networks—II: Interoffice Trunking Problems
- RM-1737 Notes on Linear Programming—Part XXXIII: A Theorem on Flows in Networks
- RM-1798 Notes on Linear Programming—Part XXXIV: A Primal-Dual Algorithm for the Capacitated Hitchcock Problem

- RM-1799 Notes on Linear Programming—Part XXXVII: Concerning Multicommodity Networks
- RM-1833 Notes on Linear Programming—Part XXXVI: The Allocation of Aircraft to Routes—An Example of Linear Programming under Uncertain Demand
- RM-1977 Notes on Linear Programming—Part XL: Network Flow and Systems of Representatives
- RM-1981 Notes on Linear Programming—Part XLI: Constructing Maximal Dynamic Flows from Static Flows
- RM-2152 Notes on Linear Programming—Part XLIV: Transient Flows in Networks
- RM-2159 Notes on Linear Programming—Part XLV: A Network-flow Feasibility Theorem and Combinatorial Applications
- RM-2178 Notes on Linear Programming—Part XLVI: Bounds on the Primal-Dual Computation for Transportation Problems
- RM-2338 On Network Flow Functions: Notes on Linear Programming and Extensions—Part 50
- RM-2480 On the Equivalence of the Capacity-constrained Transshipment Problem and the Hitchcock Problem: Notes on Linear Programming and Extensions—Part 53
- RM-3075-PR Expected Critical Path Lengths in PERT Networks
 - P-282 Efficient Transportation in Networks
- P-308 Activity Analysis and the Prediction of Traffic Flows
- P-437 The Determination of Traffic in a Road Network: An Economic Approach
- P-448 The Allocation of Switching Work in a System of Classification Yards
- P-605 Maximal Flow through a Network
 - P-651 Mathematical Aspects of Scheduling Theory
- P-677 Computation of Maximal Flows in Networks
 - P-681 Note on a Theorem of Dilworth
 - P-687 Determination of the Maximal Steady State Flow of Traffic through a Railroad Network
- P-743 A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem
- P-798 A Theorem on Flows in Networks
- P-827 A Primal-Dual Algorithm for the Capacitated Hitchcock Problem
- P-890 Hitchcock Transportation Problem
 - P-895 Solving the Transportation Problem
 - P-923 Network Flow Theory
- P-967 Constructing Maximal Dynamic Flows from Static Flows
- P-990 Network Flow and Systems of Representatives
- P-1079 Construction of Maximal Dynamic Flows in Networks
 - P-1114 A Suggested Computation for Maximal Multi-commodity Network Flows
- P-1188 A Feasibility Criterion for Staircase Transportation Problems and an Application to a Scheduling Problem
- P-1264 Transient Flows in Networks
 - P-1278 A Network Flow Feasibility Theorem and Combinatorial Applications
- P-1315 Comments on "Solution of the Quota Problem by a Successive-reduction Method"
- P-1345 On the Shortest Route through a Network
- P-1401 Increasing the Capacity of a Network: The Parametric Budget Problem
- P-1417 On k th Best Policies
- P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
 - P-1502 A Machine-job Scheduling Model
- P-1532 The Dual of a Transportation Problem Is Not a Transportation Problem
- P-1825 An Out-of-kilter Method for Minimal Cost Flow Problems
- P-1947 A Network Flow Computation for Project Cost Curves
- P-2069 Hamiltonian Paths on Convex Polyhedra
 - P-2185 On Network Flow Functions
 - P-2211 Principles of Invariance in Transport Theory
 - P-2268 On a New Computational Solution of Time-dependent Transport Processes—I: One-dimensional Case

MATHEMATICS—continued

TRANSPORTATION PROBLEMS AND NETWORK THEORY—continued

- P-2359 Overlapping Tessellated Communications Networks
- P-2371 Minimal k -Arc-connected Graphs

UTILITY THEORY

- RM-67 On the Concept of Utility and Decision-making
- RM-109 Construction of Group Preference Relations by Iteration
- RM-296 A Numerical Scale for Partially Ordered Utilities
- RM-675 Axioms for Measurable Utility
- RM-698 An Embedding of a Utility Space in an Ordered Vector Space
- RM-724 A Generalization of Numerical Utilities
- RM-780 A Preference Experiment
- P-256 A Preference Experiment
- P-258 A Preference Experiment
- P-263 A Preference Experiment
- P-319 An Axiomatic Approach to Measureable Utility
- P-321 University of Michigan—RAND Summer Session Papers
- P-331 The Logical Structure of the Utility Concept
- P-336 Multidimensional Utilities
- P-470 Notes on the Optimal Choice of Weapons
- P-2450 Partially Controllable Random Walk

WAR GAMING

- RM-1338 Analytic Formulation of a Theater Air-Ground Warfare System (1953 Techniques)
- RM-1428 Narrative Description of an Analytic Theater Air-Ground Warfare System
- RM-1744 The Distribution of Radial Error and Its Statistical Application in War Gaming
- RM-2413 War Gaming Methodology
- P-1473 The Distribution of Radial Error and Its Statistical Application in War Gaming
- P-1840 The Contextual Study: A Structured Approach to the Study of Political and Military Aspects of Limited War
- P-1902 Strategic Gaming
- P-2072 The Implications of Some Game-theoretic Analyses for War Gaming
- P-2117 The "Contextual Study" Method as a Device for Studying Limited-war Strategies
- P-2123 Gaming Limited War

METEOROLOGY—See also Geophysics and Space Flight

FALLOUT

- R-309 Close-in Fallout
- RM-1359 Computation of Radiation Level in the Vicinity of a Distribution of Contaminating Material
- RM-1583-1 Close-in H-bomb Effects
- RM-1676-AEC A Catalog of Fallout Patterns
- RM-1956 Note on the Sr^{90} Hazard
- RM-1969 Radioactive Contamination from a Multibomb Campaign
- RM-2006 Rate of Fall through the Atmosphere of Irregularly Shaped Particles
- RM-2108 Graphical Methods for the Quantitative Prediction of Close-in Fallout
- RM-2409 Note on the Strontium-90 Fallout
- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
- P-822-AEC Close-in Fallout
- P-881-AEC Atomic Cloud Height as a Function of Yield and Meteorology
- P-882-AEC A Mathematical Model of the Phenomena of Radioactive Fallout
- P-883-AEC Rain Scavenging of Radioactive Particulate Matter from the Atmosphere
- P-1091 Atmospheric Transport and Close-in Fallout of Radioactive Debris from Atomic Explosions
- P-1107 The Graphical Integration of the One-parameter Model with Terrain Effects

- P-1735 Spectral Measurements of Atmospheric Radiation from a Meteorological Satellite
- P-1759 Transient Effects in the Distribution of Carbon-14 in Nature
- P-1782 Carbon-14 Production from Nuclear Explosions
- P-1879 The Accuracy of Winds Derived by the Radar Tracking of Chaff at High Altitudes
- P-1921 The Vertical Motion of Solid Spheres in the Atmosphere
- P-2079 Mie Scattering with Complex Index of Refraction
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options

FORECASTING AND WEATHER STUDIES

- R-365 Inquiry into the Feasibility of Weather Reconnaissance from a Satellite Vehicle
- RM-885 U.S. Flying Weather
 - RM-2080 A Method for Evaluating Environmental Effects on Military Operations
 - RM-2322 Evaluation of the Effect of Environment on Refueling Operations
- RM-2607 The Forces between Conducting Spheres in a Uniform Electric Field
- RM-3049-PR Essential Factors of Thunderstorm Forecasting
- P-769 Climatology: Complex, Dynamic, and Synoptic
 - P-883-AEC Rain Scavenging of Radioactive Particulate Matter from the Atmosphere
- P-887 Detailed Analysis of Synoptic Weather as Observed from Photographs Taken on Two Rocket Flights over White Sands, New Mexico, July 26, 1948
 - P-912 A Systematic Approach to Local Objective Forecast Studies
- P-1108 A Physical Basis for Forecasting the Pressure and Horizontal Wind Fields in the Lower Stratosphere
 - P-1299 Meteorological Aspects of Infrared Operations
 - P-1631 Magnetic Storms
 - P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1727 The Summertime Reversal of Winds in the Lower Stratosphere
- P-1824 The Mutual Attraction of Cloud Droplets in the Electrostatic Field of the Atmosphere
- P-1829 Dynamic Similarity and the Modeling of Cloud Droplets
- P-1895 The Evaluation of the Effect of the Environment on a Complex Operation
 - P-1920 A Comparison of Hydrodynamic and Electrostatic Forces on Cloud Droplets
 - P-1960 Some Electrostatic Cloud-droplet Collision Efficiencies
 - P-2121 Calculations of Cloud Electrification Based on a General Charge Separation Mechanism
 - P-2134 The Role of the Electrostatic Field in the Coagulation of Fog and Cloud Droplets
 - P-2262 Statistical Determination of Error in Parachute-derived Wind Velocities
 - P-2345 Recalculations of Cloud Electrification Based on a General Charge-separation Mechanism

MISCELLANEOUS

- RM-635 Hours of Darkness at Altitude
 - RM-1153-AEC Ionization of Radioactive Particles in the Free Air
 - RM-1377 The Influence of a Variable Atmosphere on the Blast from a High Burst
- RM-2172 A Possible Transponding System for an Artificial Asteroid
- RM-2502 Extension of the "WKB" Approximation of High-frequency Scattering by a Dielectric Sphere—Part I: General Expressions
- RM-2879-PR The Gravitational Concentration of Particulate Matter in the Space near the Earth
- RM-2951-PR The Effect of Surface Temperature Variations on the Polar Night Jet
 - P-259 A Quantitative Analysis of Two Proposed Mechanisms for Vertical Ozone Transport in the Lower Stratosphere
 - P-532 Relationship between the Masses and Magnitudes of Small Meteoroids
- P-542 Quantitative Estimate of Frequency and Mass Distribution of Dust Particles Causing the Zodiacal Light Effect
 - P-701-AEC Ionization of Radioactive Particles in the Free Air
- P-733 Scientific Use of an Artificial Satellite
 - P-881-AEC Atomic Cloud Height as a Function of Yield and Meteorology
 - P-883-AEC Rain Scavenging of Radioactive Particulate Matter from the Atmosphere
- P-887 Detailed Analysis of Synoptic Weather as Observed from Photographs Taken on Two Rocket Flights over White Sands, New Mexico, July 26, 1948
- P-1509 Spectrographic Observations of the Blue Haze in the Atmosphere of Mars

METEOROLOGY—continued

MISCELLANEOUS—continued

- P-1535 On Lunar and Planetary Experiments
- P-1541 Lines of Force of the Geomagnetic Field in Space
- P-1565 On the Role of Clear Sky Turbidity in Atmospheric Infrared Transmission
- P-1726 Remarks on Auroral Isochasms
- P-1753 Geomagnetic Control of Auroral Phenomena
- P-1816 Polar Auroral, Geomagnetic, and Ionospheric Disturbances
- P-1830 Drag Coefficients of Small, Irregular Particles
- P-1880 Atmospheric Extinction of Infrared Radiation
- P-1920 A Comparison of Hydrodynamic and Electrostatic Forces on Cloud Droplets
- P-1960 Some Electrostatic Cloud-droplet Collision Efficiencies
- P-2003 Temperature and Circulation of the Venus Atmosphere
- P-2047 Interactions of Infrared Radiation with the Atmosphere: A Guide to the Modern Literature
- P-2099 Utilization of Space from a National Standpoint
- P-2213 A New Interpretation of the Structure and CO₂ Content of the Venus Atmosphere
- P-2370 Analysis of the Formation of Meteor Crater, Arizona: A Preliminary Report
- P-2387 On the Consequences of a Possible Ozonosphere on Mars
- P-2399 Detection of Nuclear Explosions
- P-2434 The Problem of Detecting Nuclear Explosions
- P-2477 The Mesosphere
- P-2516 Meteorological Rockets Step Upward
- T-117 Advances in Meteorite Research

UPPER ATMOSPHERE AND IONOSPHERE

- R-339 Aerodynamics of the Upper Atmosphere
- R-368 Geomagnetic Field Lines in Space
- R-393-PR Light Scattering on Partially Absorbing Homogeneous Spheres of Finite Size
- RM-71 Tables of Dynamic Pressure
- RM-272 The Rate of Dissociation of Air
- RM-841 Physical Properties of the Upper Atmosphere
- RM-1047 An Investigation of Atmospheric Properties at Great Altitudes
- RM-1505 Estimate of Average Atmospheric Properties between 500 km and 1000 km
- RM-2006 Rate of Fall through the Atmosphere of Irregularly Shaped Particles
- RM-2008 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
- RM-2106 Evolution and Nature of the Lunar Atmosphere
- RM-2275 Recent Results of High-altitude Research by Means of Rockets and Satellites
- RM-2286 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- RM-2740 D-layer Ionization Loss Rates
- RM-2932-PR Concerning a Certain Effect in the Field of Meteor Aerodynamics
- RAOP-3 The G-layer of the Ionosphere
- RAOP-4 On a New Method for Exploring the Upper Ionosphere
- P-62 Heights of Ionized Regions
- P-67 Turbulence in the Upper Atmosphere
- P-246 Temperatures and Motions of the Upper Atmosphere
- P-261 Physical Properties of the Atmosphere between ~80 km and ~250 km
- P-532 Relationship between the Masses and Magnitudes of Small Meteoroids
- P-542 Quantitative Estimate of Frequency and Mass Distribution of Dust Particles Causing the Zodiacal Light Effect
- P-554 Diagram of the Structure of the Upper Atmosphere
- P-638 A Study of the Structure of the Ionosphere
- P-760 Use of an Artificial Satellite in Upper Air Research
- P-761 Synoptic Weather Observations from Extreme Altitudes
- P-835 Physical Properties of the Atmosphere from 90 to 300 Kilometers
- P-1019 Dispersion in the Upper Atmosphere
- P-1023 Properties of the Atmosphere and Ionosphere between 90 and 300 km

- P-1040 Seasonal Changes in Day-to-day Variability of Upper Air Winds near the 100 km Level of the Atmosphere
- P-1089 Electron Density Distribution in a New Model of the Ionosphere
- P-1121 Ionospheric Electric-current Systems Derived Using International Polar Year Data
- P-1157 A New Model of the Atmosphere and Ionosphere
- P-1190 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
- P-1259 Basic Objectives of a Continuing Program of Scientific Research in Outer Space
- P-1263 Studies of Ionospheric Radiophysics by Means of Satellites
- P-1287 Theory of the Solar Aureole—Part II: Applications to Atmospheric Models
- P-1335 Space-vehicle Environment
- P-1338 Temperature Dependence of the Rayleigh Scattering Coefficient in the Atmosphere
- P-1344 Physics of Solar-terrestrial Space: Lunar Flight
- P-1402 Satellite Weather Reconnaissance
- P-1426 Some Remarks on the Nature and Origin of Noctilucent Cloud Particles
- P-1520 On the Drag of a Sphere Moving in a Partially Ionized Atmosphere
- P-1553 Cosmic Terrestrial Relations
- P-1564 Upper-atmosphere Properties Based on Rocket and Satellite Data
- P-1591 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- P-1712 Meteors: Frequency, Size, and Depth of Penetration
- P-1717 Review of I.G.Y. Upper-air Results
- P-1795 The Geomagnetic Field in Space, Ring Currents, and Auroral Isochisms
- P-1813 The Upper Atmosphere as Observed with Rockets and Satellites
- P-1845 The Upper Atmosphere and Geomagnetism
- P-1876 Upper Atmosphere Studies
- P-1879 The Accuracy of Winds Derived by the Radar Tracking of Chaff at High Altitudes
- P-1940 Polar Magnetic, Auroral, and Ionospheric Phenomena
- P-1957 Note on the Direction of High Auroral Arcs
- P-1977 Geomagnetic Control of the Van Allen Radiation Belts
- P-2007 Some Consequences of Local Acceleration of Auroral Primaries
- P-2015 Ionization Loss Rates below 90 km
- P-2018 Wind Systems in the Mesosphere and Lower Ionosphere
- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts
- P-2032 Warming of the Polar Mesosphere and Lower Ionosphere in Winter
- P-2035 Geomagnetism in Relation to Aeronomy
- P-2041 A Local Reduction of F-region Ionization Due to Missile Transit
- P-2068 Observations of the Blue Haze in the Atmosphere of Mars
- P-2120 The Dynamics of the Upper Atmosphere and Its Energy Unbalance
- P-2126 Variable Atmospheric Properties Derived from Rocket and Satellite Observations
- P-2160 Positive Ions in the Lower D Region
- P-2227 Rocket Probes in the Upper Atmosphere
- P-2280 Frictional Effects and the Meridional Circulation of the Mesosphere
- P-2406 World Magnetic Survey: Introductory Remarks
- P-2474 COSPAR International Reference Atmosphere
- P-2496 Some Theorems Concerning the Motion of an Electrically Charged Particle in a Dipole Magnetic Field
- T-39 Diffusion of Meteoric Trails
- T-89 Some Results Taken from Observations of the First Russian Earth Satellites
- T-111 The Role of True Absorption in the Atmosphere of Mars

WINDS

- RA-15074 Evaluation of Missile Drift Caused by Wind
- RM-2951-PR The Effect of Surface Temperature Variations on the Polar Night Jet
- P-1108 A Physical Basis for Forecasting the Pressure and Horizontal Wind Fields in the Lower Stratosphere
- P-1879 The Accuracy of Winds Derived by the Radar Tracking of Chaff at High Altitudes
- P-2018 Wind Systems in the Mesosphere and Lower Ionosphere
- P-2262 Statistical Determination of Error in Parachute-derived Wind Velocities
- P-2354 Wind and Temperature in the Mesosphere

MISCELLANEOUS

- R-258-RC A Brief Survey of the Technology and Economics of Water Supply
- R-336-RC Research and the Ulcer Problem
- RM-1934-RC A Case Study in the Measurement of Government Output
- RM-2190-RC An Economic Analysis of the Market for Scientists and Engineers
- RM-2285-RC Some Attributes of the Changing Society
 - RM-2754 Glossary of Terms on National Security
 - RM-2824-FF Transportation for Future Urban Communities: A Study Prospectus
- RM-2878-FF A First Approximation to a RAND Model for Study of Urban Transportation
- RM-3077-PR Some Remarks on Scientific Achievement in Communist China
 - P-546-RC Cold Water on Salt Water
- P-707 Project RAND
 - P-847 Administration of Research in a Research Corporation
 - P-879-RC The Nationalization of Research and Development in the U.S.
 - P-1140-RC A Commentary on Fire Research
 - P-1296 Citizenship: The Viewpoint of Science and Technology
 - P-1326 *War-1974*: A Book Review
- P-1349-RC Is Water Different?
- P-1372-RC The Relation of Salary to the Supply of Scientists and Engineers
- P-1467-RC Technology and the Challenge of the Future
 - P-1556 Comments on Automobile Traffic
 - P-1579-RC Some Attributes of the Changing Society
 - P-1580 The Research Frontier
- P-1601 RAND: A Personal View of Its History
- P-1621-RC Proposal for a "Smog Tax"
- P-1647 Future Science and Technology of the USSR
 - P-1648 Toward a Theory of Strategy for International Conflict
 - P-1698 Some Unique Problems in the Development of Qualified Translators of Scientific Russian
 - P-1756 An Outsider Surveys the Place of Public-administration Research
 - P-1772-RC The Small World
 - P-1837-1 Guide to Russian Reference and Language Aids: An Annotated Bibliography
- P-1850 Is Deterrence Enough or Should We Be Prepared to Fight a General War in the 1960's?
 - P-1888-RC The Nature and Feasibility of War and Deterrence
- P-1919 Soviet Scientific and Technical Literature: Sources and Availability
- P-1938 The Peaceful Atom in Retrospect and Prospect
- P-2037 The Commercial Aircraft Bomb Hazard: A Possible Answer
 - P-2057-RC Water Supply for Southern California: Rationalization or Expansion?
 - P-2077 Southern California's Economy in the Sixties
 - P-2084-RC No Highway to High Purpose
 - P-2107 Appraising Soviet Astronautics
 - P-2136-RC The RAND Study of Water Supply
 - P-2236-1 RAND: The History, Operations, and Goals of a Nonprofit Corporation
 - P-2282 Reorientation of Engineers To Meet the Challenge of a Changing Technology: Industrial Aspects of the Problem
 - P-2346 Glossary of Terms on National Security
 - P-2383 Anyone for the Moon?
 - P-2414 Problems of Fire in Nuclear Warfare
 - P-2422 The Automobile: Today and Tomorrow
 - P-2439 Comments on an Article by Chas. E. Osgood, "A Psychologist's Cure for the Arms Race"
 - P-2461 By Automobile through Western Russia
 - P-2491 Russian Transliteration: Sound and Sense
 - P-2492 Data Processing for Cities
 - P-2494 Seeking Social Welfare Facts in a California County: Sacramento

- P-2501 Recovery of the Bendegó Meteorite
- P-2568 Technological Change and Local Economy

MISSILES—See also Aerodynamics and Fluid Mechanics, Bombing, Defense Studies, Navigation, Nuclear Studies, Offense Studies, Operations, Propulsion, Reconnaissance, Reliability, and Structures

BALLISTIC MISSILES

- R-273 Heat-transfer Aspects of the Atmospheric Re-entry of Long-range Ballistic Missiles
 - RM-1298 Effects of Impulsive Deflections on Ballistic Missile Trajectories
- RM-1517 Aerodynamic Research Facilities Required for the Development of Moderate and Long-range Ballistic Missiles
- RM-1641 Graphical Determination of Ballistic Trajectories: Through Outer Space with Compass and Straightedge
 - RM-1863-1 An Analysis of the Rotational Motion of a Body during Re-entry
- RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- RM-2471 A Preliminary-design Aid for Studying Component Weight Assignments in Ballistic-missile Payloads
- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2514 Search Rules for Automatic Fault Location
 - RM-2735-PR Operational Criteria for the Design of Missile Readiness Testing Programs and Equipment
- P-135 On the Accuracy of the Long-range Ballistic Rocket
- P-315 Reliability in Guided Missile Systems
- P-1839 Ballistic-missile Payload Allocation
- P-1874 Design and Operation of Ground Guidance Systems
 - P-2046 On the Problem of Ballistic Missile Defense
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
 - P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- T-105 The Interception Problems of Intercontinental Missiles

MISCELLANEOUS

- RA-15039 Ceramic Materials Research for Aircraft and Rocket Vehicles
- RA-15056 Ceramic Materials Research in the United Kingdom for Aircraft and Rocket Vehicles
- RA-15074 Evaluation of Missile Drift Caused by Wind
- R-104 An Appraisal of the Usefulness of Aluminum Alloys for Supersonic Aircraft and Guided-missile Construction
 - R-117 An Evaluation of Ceramic Materials for Aircraft and Rocket Vehicles
 - R-136 Effect of Missile Dynamics on Flight Path
- RM-66 A Method for the Evaluation of Ramjet Fuels
- RM-198 Economic Survey Report: Construction Materials for Aircraft and Guided Missiles, Electric-power Supply and Requirements
- RM-770 A Hypersonic Approximation of the Pressure Forces on Ogives
- RM-1615 Basic Supersonic Ramjet Point-design Performance
- RM-1747 On the Computational Solution of Dynamic-programming Processes—III: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Expected Damage
- RM-1748 On the Computational Solution of Dynamic-programming Processes—IV: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Probability of Success
- RM-1750 Computational Solutions of Dynamic-programming Processes—VI: On the Optimal-trajectory Problem
- RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- RM-2260 Theoretical Development for Lifting Ring-Body Configurations
- RM-2275 Recent Results of High-altitude Research by Means of Rockets and Satellites
- RM-2276 Minimal Impulse Requirements for Disorbiting Satellites

MISSILES—continued

MISCELLANEOUS—continued

- RM-2348 Lift of Slender Nose Shapes According to Newtonian Theory
- RM-2461 A Parametric Study of the Performance of Air-launched Ballistic Missiles
- RM-2735-PR Operational Criteria for the Design of Missile Readiness Testing Programs and Equipment
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- P-1327 An Introduction to Guided Missiles
- P-1479 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- P-1501 I.G.Y. Rockets and Satellites: A Report on the Moscow Meetings, August 1958
- P-1506 Performance Analysis of Plug Nozzles for Turbojet and Rocket Exhausts
- P-1521 Reliability Estimating by the Use of Random Sampling Simulation
- P-1559 The Status and Improvement of Physical Constants Needed for Precision Trajectories
- P-1564 Upper-atmosphere Properties Based on Rocket and Satellite Data
- P-1571 Some Political and Economic Aspects of Overseas Missile Bases
- P-1591 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- P-1853 The Use of Reliability Estimates in the Design of Missile Prelaunch Checkout Equipment
- P-1867 How Much Automaticity for Checkout Equipment
- P-2095 Liquid Propellant Rockets: 1960
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- P-2319 Some Limitations of Automatic Test Equipment
- P-2365 Wave-induced Motions of a Large Rocket Vehicle Drifting in a Vertical Attitude
- P-2522 Western Electronic Show and Convention (WESCON), San Francisco, California, 1961
- T-16 Some Questions of Aerodynamic Damping and Dynamic Stability
- T-44 *Red Star* Series on Guided Missiles—Part I: Construction and Methods of Application
- T-53 On the Problem of Cooling Atomic Rockets Which Utilize Thermonuclear Reactions
- T-58 Steady Nuclear Combustion in Rockets
- T-73 Some New Soviet Material on Missiles

SURFACE-TO-SURFACE MISSILES

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- R-273 Heat-transfer Aspects of the Atmospheric Re-entry of Long-range Ballistic Missiles
- RM-1298 Effects of Impulsive Deflections on Ballistic Missile Trajectories
- RM-1517 Aerodynamic Research Facilities Required for the Development of Moderate and Long-range Ballistic Missiles
- RM-1863-1 An Analysis of the Rotational Motion of a Body during Re-entry
- RAOP-23 The Design of Constant-volume Missile Fuselages Having Minimum Drag at Supersonic Speeds
- T-105 The Interception Problems of Intercontinental Missiles

NAVIGATION—See also Aircraft, Electronics, Guidance and Control, Missiles, Radar, and Space Flight

- R-144 Theory of Blind Navigation by Dynamical Measurements
- R-154 Theory of Errors in Automatic Navigation with Integrating Accelerometer Systems
- R-363 An Application of Superconductivity to Inertial Navigation
- RM-1220 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements
- RM-1321 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements: Minimum RMS Error in Computed Position
- RM-1564 Automatic Navigation Aided by Intermittent Position Fixes
- RM-1852 An Application of Superconductivity to Inertial Navigation
- RM-2264 Preliminary Analysis of a Satellite Recovery System

- RM-2276 Minimal Impulse Requirements for Disorbiting Satellites
- RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
- RM-3015-PR A Computational Procedure for Optimizing Interplanetary Trajectories
 - P-121 Theory of Blind Navigation by Dynamical Measurements
 - P-181 Lunar Parallax Method of Astronavigation
 - P-1044 Principles of Self-contained Navigation
- P-1178 An Airborne Collision-warning Device
- P-1430 Orientation and Control
- P-1559 The Status and Improvement of Physical Constants Needed for Precision Trajectories
- P-1568 A Discussion of Space Vehicle Guidance Problems
- P-1665 A Discussion of Several Concepts Used in the Optimization of Control Systems by Dynamic Programming
 - P-1764 Survival Position Location Using Star Sighting
 - P-2178 Note on the Existence of Perfect Maps
 - P-2262 Statistical Determination of Error in Parachute-derived Wind Velocities
 - P-2285 A Method for Determining Approximate Initial Conditions for Interplanetary Trajectories

NUCLEAR STUDIES—See also Aircraft, Bombing, Meteorology, Missiles, Physics, and Propulsion

NUCLEAR PHYSICS: POWERPLANTS AND REACTORS

- R-259 Survey of Reacting Mixtures Employing U^{235} , Pu^{239} , and U^{233} for Fuel and H_2O , D_2O , C, Be, and BeO for Moderator
- R-279 Critical Mixtures of Uranium and 500°F Light Water
- R-316 Externally Moderated Reactors
- RM-766 Estimation of Bremsstrahlung Radiation from Ce^{144} Powerplant
- RM-842 A Study of Homogeneous H_2O , D_2O , U^{235} Reactors with a Note on Optimum Moderating Mixtures for a Minimum U^{235} Requirement
- RM-1520 The Criticality and Some Potentialities of "Cavity Reactors"
- RM-1814 Note on Neutron Flux-current Boundary Conditions at Gaps in One-dimensional Systems
- RM-1835 (Abr.) The Criticality and Some Potentialities of "Cavity Reactors"
- RM-1870 Direct Conversion of Fission to Electric Energy in Low-temperature Reactors
- RM-2280 A Correlation of the Critical Conditions for Homogeneous Bare Reactors
- RM-2396 On Control of Reactor Shutdown Involving Minimal Xenon Poisoning
- RM-2693 Neutron Branching Processes
- P-838 Lecture Notes on the Effects of Neutron Irradiation on Reactor Fuel Composition and Reactivity
- P-931 Resonance Escape Probability in Natural Uranium and H_2O - D_2O Mixtures
- P-1076 The Soviet Atomic Power Program: Large or Small?
- P-1500 On Control of Reactor Shut-down Involving Minimal Xenon Poisoning
- P-1651 Augmentation of Nuclear-rocket Specific Impulse through Mechanical-Electrical Means
- P-1713 A Discussion of the Correlation of Critical Conditions for Bare Homogeneous Reactors
- P-1861 Space Vehicle Power Plants
- P-1985 Neutron Branching Processes
- T-17 The Possible Spread of Radioactive Infection by the Fission Products of U^{235}
- T-53 On the Problem of Cooling Atomic Rockets Which Utilize Thermonuclear Reactions
- T-55 The Russian Atomic Airplane of the Future
- T-58 Steady Nuclear Combustion in Rockets
- T-106 On an Atomic Airplane

NUCLEAR PHYSICS: SHIELDING

- R-132 Scattering and Absorption of Gamma Rays and Neutrons
- R-170 Gamma-ray Absorption Coefficients
- R-233 Notes on Multigroup Techniques for the Investigation of Neutron Diffusion
- R-240 Gamma-ray Transmission through Finite Slabs

NUCLEAR STUDIES—continued

NUCLEAR PHYSICS: SHIELDING—continued

- RM-32 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
- RM-34 Determination of Shield Thickness for Attenuation of Air-scattered Gamma Radiation
- RM-39 Bremsstrahlung Correction to Transmission of Gamma Rays through Thick Media
- RM-49 Elastic Scattering of Neutrons
- RM-81 Preliminary Analysis of Effective Polarization on Gamma-ray Transmission
- RM-248 Particle Histories for Plane Slabs
- RM-255 Experimental Program
- RM-372 Asymptotic Solutions for a Class of Integral Equations and Their Application to Neutron Transmission through a Finite Slab
- RM-766 Estimation of Bremsstrahlung Radiation from Ce^{144} Powerplant
- RM-1153-AEC Ionization of Radioactive Particles in the Free Air
- RM-1624 Weight-feasibility Calculation for Shielding of Truck Passengers
- RM-2223-AEC The Free-free Gaunt Factor in an Ionized Medium
- RM-2825-PR Solar-flare Radiation and Manned Space Flight
- RAOP-40 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
- P-138 A Note on Cullwick's Tentative Explanation of the Observed Masses of Mesons
- P-147 Gamma-ray Transmission
- P-157 Scattering and Absorption of Gamma Rays
- P-307 Spontaneous Fission versus Alpha Decay
- P-368 Attenuation of Gamma Rays—I (Transmission Values for Finite Slabs of Lead, Iron, and the Compton Scatterer) and II (Transmission Values for Various Materials and Geometries)
- P-701-AEC Ionization of Radioactive Particles in the Free Air
- P-1126 Scattering of Light by Protons

NUCLEAR WEAPONS BASIC STUDIES

- RM-18 Medical and Biological Aspects of Nuclear Energy
- RM-1372 Some German Press Views on the Defense of Europe: A Survey of West German Press Opinion on Military Aspects of the Defense of Europe
- RM-2500 An Evaluation of the Human Retinal Burn Problem Arising from Atomic Detonations
- RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-444 Military Implications of Nuclear Weapon Developments
- P-462 Some Economic Aspects of Fissionable Material
- P-669 The Influence of Mass Destruction Weapons on Strategy
- P-2399 Detection of Nuclear Explosions
- P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-2414 Problems of Fire in Nuclear Warfare
- P-2416 Economic Recovery from the Effects of Thermonuclear War
- P-2434 The Problem of Detecting Nuclear Explosions
- T-36 Chats on the Atomic Weapon
- T-37 On the New American Submarine *Nautilus*

NUCLEAR WEAPONS EFFECTS

- R-251-AEC (Amended) Worldwide Effects of Atomic Weapons: Project SUNSHINE
- R-348 A Method of Concealing Underground Nuclear Explosions
- RM-1151 Response of Drag-type Structure to Blast
- RM-1226 Residual Gamma Radiation Hazard after Limited Decontamination Operations
- RM-1285-1 Effects of Environment in Reducing Dose Rates Produced by Radioactive Fallout from Nuclear Explosions
- RM-1359 Computation of Radiation Level in the Vicinity of a Distribution of Contaminating Material
- RM-1583-1 Close-in H-bomb Effects

- RM-1677 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Response and Scaling of Floating Roof Tanks
- RM-1680 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Motion of Liquid Surface in an Open Rectangular Tank
- RM-2173 A Review of Similitude Theory in Ground Shock Problems
- RM-2270 The Response of Hypothetical Missile Transport Equipment to Nuclear Blast
- RM-2349 Summary and Recommendations regarding Underground Phenomenology
- RM-2410 The Vulnerability of Hypothetical Rail Transport for a Mobile Ballistic Missile System
- RM-2486 Impact Wave Propagation in Columns of Sand
- RM-2500 An Evaluation of the Human Retinal Burn Problem Arising from Atomic Detonations
- RM-2562-AEC Concealment of Underground Explosions
- RM-2624-AEC Cavity Explosion Calculations for the COWBOY Program
- RM-2660 Pressure Response within an Enclosure Subject to a Blast Wave
- RM-2665-AEC The Effect of Plasticity on Decoupling of Underground Explosions
- RM-2715 Structures under Repeated Blast Loadings
- RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- RM-3005-PR The Irrelevance of the GNOME Shot to Decoupling
- P-822-AEC Close-in Fallout
- P-1594 A Seismic Scaling Law for Underground Explosions
- P-1782 Carbon-14 Production from Nuclear Explosions
- P-1951 Weapons Effects for Protective Design
- P-2004-1 Impact Wave Propagation in Columns of Sand
- P-2192 Impact Wave Propagation in Columns of Sand—Part II
- P-2329 The Effect of Plasticity on Decoupling of Underground Explosions
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options
- P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-2414 Problems of Fire in Nuclear Warfare

NUCLEAR WEAPONS EMPLOYMENT

- RM-2456-AEC Probing the Earth with Nuclear Explosions
- RM-2696-AEC Power Recovery from the Kilauea Iki Lava Pool
- P-2111-AEC Probing the Earth with Nuclear Explosions

NUCLEAR WEAPONS PHENOMENOLOGY

- R-251-AEC (Amended) Worldwide Effects of Atomic Weapons: Project SUNSHINE
- RM-49 Elastic Scattering of Neutrons
- RM-81 Preliminary Analysis of Effective Polarization on Gamma-ray Transmission
- RM-477 A Variable-density Spherical-shock-wave Problem
- RM-1377 The Influence of a Variable Atmosphere on the Blast from a High Burst
- RM-1583-1 Close-in H-bomb Effects
- RM-1824-AEC Point Source Explosion in Air
- RM-1825-AEC The Blast Wave in Air Resulting from a High Temperature, High Pressure Sphere of Air
- RM-1913-AEC Space Plots of Pressure, Density and Particle Velocity for the Blast Wave from a Point Source in Air
- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
- RM-2556 Neutron Fluxes in Air: A Comparison of Monte Carlo Code Computations by RAND, Los Alamos, and Sandia
- RM-2600 Cratering from a Megaton Surface Burst
- RM-2624-AEC Cavity Explosion Calculations for the COWBOY Program
- RM-2998-PR Scabbing in Rock Tunnels
- P-801 Application of the Baldwin Crater Relation to the Scaling of Explosion Craters
- P-822-AEC Close-in Fallout
- P-881-AEC Atomic Cloud Height as a Function of Yield and Meteorology
- P-882-AEC A Mathematical Model of the Phenomenon of Radioactive Fallout
- P-883-AEC Rain Scavenging of Radioactive Particulate Matter from the Atmosphere

NUCLEAR STUDIES—continued

NUCLEAR WEAPONS PHENOMENOLOGY—continued

- P-986 Engineering Test Reactors with Large Central Irradiation Cavities
- P-1951 Weapons Effects for Protective Design
- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts
- P-2270 Boundary Effects on the Energy Loss of Charged Particles
- P-2399 Detection of Nuclear Explosions
- P-2434 The Problem of Detecting Nuclear Explosions

TRANSLATIONS

- T-35 *Red Star Series on Atomic Energy—Part I: Structure and Properties of the Nucleus*
- T-35 *Red Star Series on Atomic Energy—Part II: Radioactive Disintegration of Nuclei*
- T-35 *Red Star Series on Atomic Energy—Part III: Nuclear Reactions*
- T-35 *Red Star Series on Atomic Energy—Part IV: The Physics of a Nuclear Explosion*
- T-35 *Red Star Series on Atomic Energy—Part V: The Thermonuclear Reaction with Hydrogen*
- T-35 *Red Star Series on Atomic Energy—Part VI: Atomic Energy in the Service of the National Economy*
- T-35 *Red Star Series on Atomic Energy—Part VII: The Physics of the Behavior of Nuclear Forces—The Shock Wave*
- T-35 *Red Star Series on Atomic Energy—Part VIII: The Physics of the Behavior of Nuclear Forces—Light Radiation*
- T-35 *Red Star Series on Atomic Energy—Part IX: The Physics of the Behavior of Nuclear Forces—Penetrating Radiation*
- T-35 *Red Star Series on Atomic Energy—Part X: The Physics of the Behavior of Nuclear Forces—Radioactive Substances*
- T-35 *Red Star Series on Atomic Energy—Part XI: The Physics of the Behavior of Nuclear Forces in the Atmosphere and at Sea*
- T-35 *Red Star Series on Atomic Energy—Part XII: The Physics of the Behavior of Nuclear Forces—Radiation Measurements*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part I*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part II*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part III*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part IV*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part V*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part VI*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part I: On the Way to Controlled Nuclear Reactions*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part II: Sources of Nuclear Fuel*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part III: Nuclear Reactors*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part IV: The Nuclear Power Station*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part V: The Nuclear Fuel Engine*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part VI: The Atomic Industry—1*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part VII: The Atomic Industry—2*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part VIII: The Use of Radioactive Substances in Technology*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part IX: Nuclear Radiations and Medicine*
- T-72 Excerpt from "Construction of Aircraft" (*Konstruktsii Samoletov*) Dealing with the Evolution and Uses of Soviet Airplanes

OFFENSE STUDIES—See also Aircraft, Bombing, Defense Studies, Missiles, Operations, and Targets

ENEMY DEFENSE CAPABILITIES

- RA-15016 An Analysis of the Guided Missile—Strategic Bomber Interception Problem: App. II to Fourth Quarterly Reports, RA-15033 and RA-15034
- RM-1654 The Influence of an Aggressor's Attack Effectiveness upon the Characteristics Desired for a Defender's Air Force
- T-20 Summary of the Status of German Antiaircraft in the Final Phase of World War II
- T-105 The Interception Problems of Intercontinental Missiles

MATHEMATICAL MODELS

- RM-12 A Note on the Lanchester Equations
- RM-13 A Second Note on the Lanchester Equations
- RM-118 Note on Duels with Continuous Firing
- RM-123 An Integral Arising in Vulnerability Studies
- RM-163 Area Coverage with Ordinary Bombs
- RM-189 Note on Some Historic Principles of Target Selection
- RM-252 Composite Targets: n Identical Elements
- RM-312 Bomber Formations Analysis: Simplified Air Battle Attrition Theory
- RM-318 A Preliminary Model for an Air Battle
- RM-319 Local Defense of Targets of Equal Value
- RM-320 Local Defense of Targets of Equal Value: Extension of Results
- RM-329 Local Defense of Targets of Equal Value—Completion of Results
- RM-359 n Targets of Differing Vulnerability with Attack Stronger than Defense
- RM-517 Expected Results of a Bombing Strike, Including Reconnaissance
- RM-677 The Determination of Decision Regions for a Simplified Two-plane Bombing Model
- RM-684 Decision Functions for Bombing Models
- RM-1068 Optimum Tactics in an Air Superiority Campaign
- RM-1094 Distributions of Surviving Bombers in Certain Air Battle Models
- RM-1097 An Approximation for Computing the Survival of a Two-dimensional Diffuse Target
- RM-1335 Optimal Tactics in a Multistrike Air Campaign
- RM-1741 On the Optimal Use of Guided Missiles—I: Allocation of Missiles
- RM-1742 On the Optimal Use of Guided Missiles—II: Dummy Missiles
- RM-1898 On the Formulation of Dynamic-programming Processes—IV: On the Allocation of Bombers and Decoys
- RM-2282 On the Computational Solution of Dynamic-programming Processes—XIV: Missile-allocation Problems
- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
- RM-2471 A Preliminary-design Aid for Studying Component Weight Assignments in Ballistic-missile Payloads
- RM-2491 A Parametric Study of Surface-to-air Missiles versus Low-altitude Targets
- P-882-AEC A Mathematical Model of the Phenomenon of Radioactive Fallout
- P-1592 A Game Theory Analysis of Tactical Air War
- P-1678 An Approximating Algorithm for an Optimum Aim-points Problem
- P-1839 Ballistic-missile Payload Allocation
- P-1849 Some Military Applications of the Theory of Games
- P-2072 The Implications of Some Game-theoretic Analyses for War Gaming
- P-2138 Problems of Force Posture Evaluation

MISCELLANEOUS

- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2514 Search Rules for Automatic Fault Location
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- P-700 Remarks on the Design, Conduct, and Analysis of Large Air Exercises
- P-889 Comments on Warfare in the Next Ten to Twenty Years
- P-1017 Generalized Analysis of Aerial Campaigns against Strategic Targets

OFFENSE STUDIES—continued

MISCELLANEOUS—continued

- P-1085 Remarks on Future Wars
- P-1877 On the Value of Overseas Bases
- P-1888-RC The Nature and Feasibility of War and Deterrence
- P-1965 Deterrence of Unlimited War: A Propositional Outline

TARGETS

- △ R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes
- RM-6 Combat between Heterogeneous Forces
- RM-163 Area Coverage with Ordinary Bombs
- RM-189 Note on Some Historic Principles of Target Selection
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-252 Composite Targets: n Identical Elements
- P-1849 Some Military Applications of the Theory of Games

WEAPONS AND WEAPON SYSTEMS

- △ R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes
- R-382 Influence of Resource and Policy Changes on Aircraft Capabilities
- RM-165 A Bomber-Fighter Duel
- RM-193 A Bomber-Fighter Duel—II
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-274 Determination of Expected Coverage and of Expected Damage: Single Bomb of Large Lethal Area
- RM-306 Expected Coverage with Conventional Bombs when Rectangular Patterns Are Employed against Rectangular Targets
- RM-310 Performance Effects of Refueling
- RM-317 Application of the Photoelectric Machine: Expected Damage by a Single Weapon
- RM-1508 Some Implications of "Weapons System Support" by AMC
- RM-1786 Relationships between Weapons and Logistics Expenditures
- P-497 Atomic Weapons and Ground Combat: Search for Organization and Doctrine
- P-669 The Influence of Mass Destruction Weapons on Strategy
- P-880 Weapons System Philosophy

OPERATIONS—See also Aircraft, Bombing, Defense Studies, Logistics, Missiles, Offense Studies, Reconnaissance, and Targets

AIR BATTLE

- R-212 Air War and Emotional Stress: Psychological Studies of Bombing and Civilian Defense
- RM-118 Note on Duels with Continuous Firing
- RM-131 The Noisy Duel, One Bullet Each, Arbitrary Nonmonotone Accuracy
- RM-165 A Bomber-Fighter Duel
- RM-168 Survival Chance with Correlation in Aim
- RM-193 A Bomber-Fighter Duel—II
- RM-195 The Problem of Cunningham and Hynd
- RM-206 A Generalization of the Silent Duel, Two Opponents, One Bullet Each, Arbitrary Accuracy
- RM-213 The Duel with Time of Flight Not Zero
- RM-233 Application of Concepts from Kinetic Theory of Gases to Interception Problem
- RM-239 Air Battle Theory: Statistical Survival Analysis for Close-controlled Interceptors versus Bombers
- RM-240 Basic Survival-probability Expressions for Air Combat Models
- RM-245 Climb Path for Least Elapsed Time

- RM-246 A Study To Determine the Flight Paths Which Require Minimum Time and Minimum Fuel for a Typical Present-day Interceptor
- RM-286 Pursuit Path Method: Maneuvering Bomber
- RM-312 Bomber Formations Analysis: Simplified Air Battle Attrition Theory
- RM-316 Maneuvering and Scanning Barriers for All-weather Interceptions: A Graphical Method
- RM-318 A Preliminary Model for an Air Battle
- RM-400 Two-airplane Formation Design: Generalized Theory
- RM-444 A Remark on the Silent Duel with Positive Initial Accuracy, and on Associated Silent and Noisy Duels
- RM-445 The Silent Duel, One Bullet versus Two, Equal Accuracy
- RM-575 Conversion of Interceptor Design Parameters and Cost to Air Battle Parameters for a 1954-1958 Air Battle Analysis
- RM-713 Ratio of Crew to Aircraft Requirements as Affected by Attrition
- RM-791 A Pursuit Game with Incomplete Information
- RM-863 The Generalized Outcome of a Class of Machine-gun Duels
- RM-1171 A Tactical Air Game
- RM-1415 A Two-machine-gun Duel with the Bomber Turret Vulnerable
- P-302 Emotional Stress and Air War
- P-527 Some Notes on the Evolution of Air Doctrine
- P-899 War Gaming as a Technique of Analysis
- P-1085 Remarks on Future Wars

CENTRAL WAR

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-1842 Implications of Nuclear Weapons in Total War
- RM-1926-RC NATO Deterrent vs. Shield
- RM-2952-PR Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
- P-889 Comments on Warfare in the Next Ten to Twenty Years
- P-983 Deterrence Is Not Enough
- P-1085 Remarks on Future Wars
- P-1384 A Vulnerability Model for Weapon Sites with Interdependent Elements
- P-1675 Why Go Deep Underground?
- P-1748 What Interdependence for NATO?
- P-1850 Is Deterrence Enough or Should We Be Prepared To Fight a General War in the 1960's?
- P-1888-RC The Nature and Feasibility of War and Deterrence
- P-1927 Lecture on Civil Defense
- P-1965 Deterrence of Unlimited War: A Propositional Outline
- P-2046 On the Problem of Ballistic Missile Defense
- P-2138 Problems of Force Posture Evaluation
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- P-2274-1 Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
- P-2352 Concepts of Limited War: An Historical Approach
- T-95 On the Prevention of Surprise Attack

LIMITED WAR

- R-356 China Crosses the Yalu: The Decision To Enter the Korean War
- RM-1926-RC NATO Deterrent vs. Shield
- RM-2224 The Meaning of Limited War
- RM-2413 War Gaming Methodology

OPERATIONS—continued

LIMITED WAR—continued

- RM-2510 Nuclear Weapons and Limited War
- RM-2561 Communist Strategy in Laos
- P-889 Comments on Warfare in the Next Ten to Twenty Years
- P-1085 Remarks on Future Wars
- P-1222 The Meaning of Limited War
- P-1566 The Place of Limited War in NATO Strategy
- P-1620 Nuclear Weapons and Limited War
- P-1840 The Contextual Study: A Structured Approach to the Study of Political and Military Aspects of Limited War
- P-2059 The Korean War: Political Limitations
- P-2117 The "Contextual Study" Method as a Device for Studying Limited-war Strategies
- P-2123 Gaming Limited War
- P-2352 Concepts of Limited War: An Historical Approach
- P-2433 On Local War Doctrine
- P-2466 The Use of War Games in Command and Control Analysis

LOGISTICS

- RA-15015 A Problem in Logistics: The Jeep Problem
- RA-15019 A Problem in Logistics: The Jeep Problem (Part 2)—App. IV to Fourth Quarterly Report, RA-15033
- R-292 Characteristics of Demand for Aircraft Spare Parts
- R-382 Influence of Resource and Policy Changes on Aircraft Capabilities
- RM-224 A Mathematical Model of an Air Transportation System
- RM-267 Illustrative Example of Application of Koopmans' Transportation Theory of Scheduling Military Tanker Fleet
- RM-406 Routing of Empties for Fixed-schedule Transportation
- RM-555 The Capacity of a Railroad Freight Yard (A Survey of the Problem—Not a Solution)
- RM-614 Note on the Formulation of the Study of Logistics
- RM-647 On a General Class of Problems Involving Sequential Analysis
- RM-648 On a Transportation Problem
- RM-690 An Inventory Problem—The Bankruptcy Question
- RM-730 Time, Equipment, and Costs To Repair Cratered Runways
- RM-951 The Problem of Defining and Measuring Railroad Capacity
- RM-1190 Some Characteristics of Manufacturers' Parts Numbers Now Included in Air Force Catalogs
- RM-1296 Consistency Problems in the Military Supply System
- RM-1297 Analysis of the Demand Patterns for B-47 Airframe Parts at Air Base Level
- RM-1300 Predictability of Demand for B-47 Airframe Spare Items
- RM-1357 Confidence Intervals for Poisson Parameters in Logistics Research
- RM-1380 Cargo Density and Air Transportation
- RM-1392 The Cost of Various Base Stocking and Requisitioning Policies for Aircraft Spare Parts
- RM-1402 A Summary of Some Base Supply Activity and Workload Reports
- RM-1413 The Prediction of Demand for Aircraft Spare Parts Using the Method of Conditional Probabilities
- RM-1417 A Proposal for a New Air Force Supply Procedure
- RM-1430 A Resource Allocation Problem in Continuous Form
- RM-1431 Analysis of Base Stockage Policies
- RM-1490 A Preferred Method for Designing a Flyaway Kit
- RM-1508 Some Implications of "Weapons System Support" by AMC
- RM-1519 A Model of the Procurement-Repair Decision for a Spare Item

- RM-1541 The Effectiveness of Alternative Flyaway Kits
- RM-1592 Steam Locomotive Availability and Terminal Facilities
- RM-1604 Notes on Linear Programming—Part XXIX: A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem
- RM-1612 Allocating MATS Equipment with the Aid of Linear Programming
- RM-1621 A Technique for Optimal Distribution of Available Stocks to Bases
- RM-1639-1 Research and Development of a New Data-processing System for Air Force Logistics
- RM-1640 The Relation of Aircraft Status Data to the Logistics System
- RM-1647 A Concept of Mechanized Transportation Data Processing
- RM-1658 The Allocation of MATS Airlift—January, 1956: Pacific Ocean Area
- RM-1754 A Revised Data-processing System for Managing War Reserve Stocks of Aircraft Spare Parts
- RM-1785 Costs and Benefits in Mathematical Programming
- RM-1786 Relationships between Weapons and Logistics Expenditures
- RM-1803 Base-Depot Model Studies
- RM-1817 Air Force Logistics: Some Recent Developments
- RM-1830 Air Force Provisioning Policies: An Analysis
- RM-1853 Cargo Density and Airlift
- RM-1889 On the Computational Solution of Dynamic-programming Processes—X: The Flyaway-kit Problem
- RM-1890 A Briefing on a Method of Estimating Spare Part Essentiality
- RM-2365 Supply and Depot-repair Interactions: A Case Study of Electronics Support
- RM-2374 The Base Maintenance-operations Model Used in RAND Logistics Research
- RM-2418 The Base Repair Cycle for the F-102 Fire Control System
- RM-2451 A Model for Assessing the Effect of Maintenance on Missile Launch Probability
- RM-2483 The Design of Complex Management Control Systems
- RM-2566 Aircraft Compartment Design Criteria for the Army Deployment Mission
- RM-2656 Base-depot Requisitioning Pipeline Times
- RM-2685 Standardization of Automatic Test and Checkout Equipment: A Preliminary Discussion
- RM-2731 An Experiment in Aircraft Status Prediction
- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography
- RM-2767 Spare Parts Inventories for NATO
- RM-2810-PR Rules for Planned Replacement of Aircraft and Missile Parts
- RM-2810-PR (Abr.) Rules for Planned Replacement of Aircraft and Missile Parts
- RM-2989-PR Solution of a Simple Overhaul Problem
- RM-3014-PR When To Stop Sampling and Initiate Product Improvement
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
- P-1548 A Simulation Model of Air Force Maintenance Operations
- P-1810 Measuring Missile Reliability in Pre-launch Environments
- P-1826 A Structural Approach to Military Air Transportation
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1868 Logistics Research and Management Science
- P-1882 A Model for Evaluating Fleets of Transport Aircraft
- P-1981 Support Resources
- P-2053 The Effect of Maintenance and Reliability on the Operational Effectiveness of an Interceptor Squadron
- P-2076 Compatibility of Military and Commercial Airlift Requirements
- P-2082 Aircraft Compartment Design Criteria for the Army Deployment Mission
- P-2153 Standards, Standardization, and Test Equipment
- P-2317 A Malfuction-generation Model for a Manned Simulation of ICBM Logistics
- P-2319 Some Limitations of Automatic Test Equipment
- P-2322 The Use of Manned Simulation in the Design of an Operational Control System
- P-2355 Game-simulation and Long-range Planning

OPERATIONS—continued

LOGISTICS—continued

- P-2435 Status Prediction of Scheduled Equipment
- P-2453 Throw-away Maintenance Policies
- P-2563 Planned Replacement

MISCELLANEOUS

- RM-2415 The Flight Operations Planner
- RM-2525 Addendum to RM-2415, *The Flight Operations Planner*
- RM-2754 Glossary of Terms on National Security
- P-199 Optimum Trajectories
- P-526 Nonmilitary Applications of Operations Research
- P-1017 Generalized Analysis of Aerial Campaigns against Strategic Targets
- P-1895 The Evaluation of the Effect of the Environment on a Complex Operation
- P-2009 Time and Civil Defense
- P-2084-RC No Highway to High Purpose
- P-2138 Problems of Force Posture Evaluation
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- P-2346 Glossary of Terms on National Security

OPERATIONS ANALYSIS

- RA-15005 The Interim Study
- RA-15008 Effect on Military Worth of Exchanging Bombing Accuracy for Bomber Safety by Increasing Range of Bomb
- RM-10 An Experiment in Estimation
- RM-37 The Concept of Military Worth
- RM-92 Forecast of Production Time
- RM-177 On the Usefulness of Artificial Dispersion for a Certain Bombing Problem
- RM-197 Application of Theory of Games to Identification of Friend and Foe
- RM-239 Air Battle Theory: Statistical Survival Analysis for Close-controlled Interceptors versus Bombers
- RM-240 Basic Survival-probability Expressions for Air Combat Models
- RM-286 Pursuit Path Method: Maneuvering Bomber
- RM-388 Human Factors in Systems Analysis
- RM-619 Formulating Precise Concepts in Organization Theory
- RM-709 Report of a Seminar on Organization Science
- RM-769 Behavior Strategies in Finite Games
- RM-890 The Systems Research Laboratory and Its Program
- RM-922 Observations and Comments on the Organization Studies of the Systems Research Laboratory
- RM-1085 Process Analysis of the Metal-working Industries
- RM-1575 The Contextual Map
- RM-1678 An Introduction to Systems Analysis
- RM-1723 The Views of Corporation Executives on the Probable Effect of the Loss of Company Headquarters in Wartime
- RM-1829 Techniques of Systems Analysis
- RM-1916 Data for Testing a Model of Organizational Behavior
- RM-2080 A Method for Evaluating Environmental Effects on Military Operations
- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2491 A Parametric Study of Surface-to-air Missiles versus Low-altitude Targets
- RM-2514 Search Rules for Automatic Fault Location
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- RM-2735-PR Operational Criteria for the Design of Missile Readiness Testing Programs and Equipment

RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design

- P-526 Nonmilitary Applications of Operations Research
- P-700 Remarks on the Design, Conduct, and Analysis of Large Air Exercises
- P-929 A Failure Model for Equipments Undergoing Complex Operation
- P-1285 A Simple Device for Assessing Gun-camera Film against Banner Targets
- P-1849 Some Military Applications of the Theory of Games
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1867 How Much Automaticity for Checkout Equipment
- P-1888-RC The Nature and Feasibility of War and Deterrence
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
- P-2123 Gaming Limited War
- P-2138 Problems of Force Posture Evaluation
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2462-1 Science and Statecraft

STRATEGIC WARFARE

- R-165 Notes on Strategic Air Intelligence in World War II (ETO)
- R-335 Strategy in the Missile Age
- RM-645 On a Geometrical Game Connected with Sequential Analysis
- RM-647 On a General Class of Problems Involving Sequential Analysis
- RM-720 Campaigns against Nonuniform Target Systems
- RM-787 A Simplified Study of Reconnaissance in Strategic Bombing Campaigns
- RM-1072 The Rate of Advance of the Front Line in Some World War II Campaigns
- RM-1684 Appendix to RM-1683: A Soviet Target Complex for Strategic Systems Studies—Base-to-target Distances
- RM-1866 Strategic Air Power in World War II
- RM-1926-RC NATO Deterrent vs. Shield
- RM-2322 Evaluation of the Effect of Environment on Refueling Operations
- P-1017 Generalized Analysis of Aerial Campaigns against Strategic Targets
- P-1085 Remarks on Future Wars
- P-1748 What Interdependence for NATO?
- P-1849 Some Military Applications of the Theory of Games
- P-2138 Problems of Force Posture Evaluation
- P-2183 The Crude Analysis of Strategic Choices
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- P-2352 Concepts of Limited War: An Historical Approach

TACTICAL WARFARE

- RM-205 A Tactical Reconnaissance Model
- RM-913 Aerial Bombing Tactics: General Considerations (A World War II Study)
- RM-1171 A Tactical Air Game
- RM-1338 Analytic Formulation of a Theater Air-Ground Warfare System (1953 Techniques)
- RM-1428 Narrative Description of an Analytic Theater Air-Ground Warfare System
- RM-1745 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel
- RM-1877 Optimal Employment of Tactical Air Forces in Theater Air Tasks: A Game-theoretic Analysis
- RM-1926-RC NATO Deterrent vs. Shield
- RM-2137 Optimal Employment of Tactical Air Forces in Theater Air Tasks—II: A Game-theoretic Analysis
- RM-2399 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- RM-2491 A Parametric Study of Surface-to-air Missiles versus Low-altitude Targets
- P-700 Remarks on the Design, Conduct, and Analysis of Large Air Exercises
- P-1063 A Tactical Air Game

OPERATIONS—continued

TACTICAL WARFARE—continued

- P-1072 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel
- P-1285 A Simple Device for Assessing Gun-camera Film against Banner Targets
- P-1748 What Interdependence for NATO?
- P-1849 Some Military Applications of the Theory of Games
- P-1914 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- P-2072 The Implications of Some Game-theoretic Analyses for War Gaming
- T-28 Russian Tactics

OPERATIONS RESEARCH—See Systems Analysis

PHYSICS—See also Aerodynamics and Fluid Mechanics, Geophysics, and Nuclear Studies

ASTROPHYSICS

- RM-1900 Visual Detection of Light Sources On or Near the Moon
- RM-2172 A Possible Transponding System for an Artificial Asteroid
- P-343 Relativity Precession of Minor Planets
- P-351 The Radiative Opacity of Stellar Matter
- P-581 A Note on Infrared Stellar Magnitudes
- P-875 Temperatures in the Earth's Interior
- P-1259 Basic Objectives of a Continuing Program of Scientific Research in Outer Space
- P-1344 Physics of Solar-Terrestrial Space: Lunar Flight
- P-1406 Experiments in Interplanetary Biomigration and Space Contamination
- P-1409 Lunar Rays: Their Formation and Age
- P-1425 Prologue to a Syntax of Space Exploration
- P-1442 Some Aspects of Astronautics
- P-1460 Earth-period (24-hour) Satellites
- P-1509 Spectrographic Observation of the Blue Haze in the Atmosphere of Mars
- P-1717 Review of I.G.Y. Upper-air Results
- P-1801 A Scientist's Notes on the Cold War
- P-1970 Problems and Concepts of General Planetology
- P-2079 Mie Scattering with Complex Index of Refraction
- P-2099 Utilization of Space from a National Standpoint
- T-52 The Motion of a Satellite Station around the Earth in an Elliptical Orbit Inclined to the Earth's Equator
- T-54 Possibilities of Transition from an Elliptical Orbit to a Circular Orbit, and Vice Versa
- T-81 The Equation of State of Hydrogen at High Pressures

ATOMIC PHYSICS: ABSORPTION AND OPACITY

- RM-1487-AEC Line Broadening by Electrons: The Validity of Simple Theories
- RM-1551 Approximate Values for the Continuous Absorption Coefficient of Air between 2 and 600 Volts
- RM-1554 Absorption Coefficients of Air from 6000°K to 18,000°K
- RM-1578-AEC Photoelectric K and L Shell Absorption Coefficients for Highly Ionized Atoms
- RM-1670-AEC The Validity of the Statistical Theory of Pressure Broadening
- RM-1743 A Table of the Planck Radiation Function and Its Integral
- RM-1779-AEC Stark Effects in Line Broadening
- RM-2010-AEC Free-free Gaunt Factors
- RM-2091-AEC Hydrogenic Bound-free Gaunt Factors
- RM-2118-AEC New Developments in the Theory of Pressure Broadening
- RM-2272-AEC Relativistic Self-consistent Calculation for the Normal Mercury Atom
- RM-2275 Recent Results of High-altitude Research by Means of Rockets and Satellites
- RM-2367-AEC Graphs of X-ray Absorption Coefficients for Fourteen Substances

- RM-2372-AEC Relativistic Self-consistent Calculation for the Normal Uranium Atom
- RM-2404-AEC Relativistic Self-consistent Calculation for the Normal Tungsten Atom
- RM-2405-AEC Relativistic Self-consistent Calculation for the Normal Platinum Atom
- RM-2406-AEC Relativistic Self-consistent Calculation for the Iron Atom
- RM-2447-AEC The Emissive Power of Ionized Hydrogen Gas
- RM-2502 Extension of the "WKB" Approximation of High-frequency Scattering by a Dielectric Sphere—Part I: General Expressions
- RM-2580-AEC Fermi-Dirac Averages of the Free-free Hydrogenic Gaunt Factor
- RM-2610-AEC Some Statistical Properties of Level and Line Distributions in Atomic Spectra
- RM-2776-AEC The Mössbauer Effect
- RM-2798-AEC The Strength of Underground Cavities of Spherical and Spheroidal Geometry
- RM-2947-AEC On the Energy Distribution of Terms and Line Arrays in Atomic Spectra
- RM-3027-PR A Complete Solution of the X and Y Equations of Chandrasekhar
- RM-3050-PR Collision Damping of Plasma Oscillations
- P-351 The Radiative Opacity of Stellar Matter
- P-672 Line Broadening by Electrons: The Validity of Simple Theories
- P-732 Line Width Problems in Hot Dense Atmospheres
- P-872-AEC Photoelectric K and L Shell Absorption Coefficients for Highly Ionized Atoms
- P-897 Atmospheric Transmission
- P-1564 Upper-atmosphere Properties Based on Rocket and Satellite Data
- P-1645 An Approximation Method for Large-angle Scattering of High-energy Scalar and Vector Waves
- P-1777-AEC Relativistic Self-consistent Solutions for Atoms of Large Atomic Number
- P-1790-AEC Electron Radiative Transitions in a Coulomb Field
- P-1880 Atmospheric Extinction of Infrared Radiation
- P-2271 A New Approach to the Quantum Electrodynamics of a Medium
- T-63 The Scattering of Light in Planetary Atmospheres

ATOMIC PHYSICS: EQUATION OF STATE

- R-277 Equations of State on the Thomas-Fermi Statistical Model
- RM-1227 Equation of State on the Thomas-Fermi Model—Part I: Non-zero Temperature
- RM-1228 Equation of State on the Thomas-Fermi Model—Part II: Zero Temperature without Exchange
- RM-1229 Equation of State on the Thomas-Fermi Model—Part III: Zero Temperature with Exchange
- RM-1344-AEC Equation of State of Air on the Statistical Model
- RM-1492-AEC Equation of State of Water
- RM-1511-AEC Abstract Compendium on Theoretical Equation of State for Solids
- RM-1574-AEC The Equation of State of Water on the Thomas-Fermi Model
- RM-1824-AEC Point Source Explosion in Air
- RM-1847-AEC Thomas-Fermi Equation of State for Dilute Gases
- RM-2899-AEC Quasi-classical Theory of Electron Correlations in Atoms
- P-147 Gamma-ray Transmission
- P-776-AEC The Equation of State of Water on the Thomas-Fermi Model
- T-81 The Equation of State of Hydrogen at High Pressures

ATOMIC PHYSICS: PHYSICAL CHEMISTRY

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-272 The Rate of Dissociation of Air
- RM-1669 Estimate of Pressure Effects on NO-band Lines
- RM-1670-AEC The Validity of the Statistical Theory of Pressure Broadening
- RAOP-28 The Automatic Sampling of Gases at High Temperatures and Pressures
- P-120 The Thermodynamic Properties of Boric Oxide and of Aluminum Oxide in the Ideal Gaseous State
- P-128 Kinetic Study of the Thermal Decomposition of Hydrazine Vapor in a Silica Vessel
- P-237 Chemical Kinetics and Rocket Nozzle Design
- P-582 The Blast from a Sphere of High-pressure Gas

PHYSICS—continued

ATOMIC PHYSICS: PHYSICAL CHEMISTRY—continued

- P-1286 Chemical Thermodynamics in Rocket Nozzles
- P-1628 Comments on Electrical Power Supplies for Underground Shelters
- P-2213 A New Interpretation of the Structure and CO_2 Content of the Venus Atmosphere
- T-60 The Theory of Mixture Preparation in Continuously Burning Combustion Chambers
(Parts I and II)

ATOMIC PHYSICS: PLASMA

- RM-1446-AEC The Lindemann and Grüneisen Laws
- RM-1447-AEC Stark Fields from Ions in a Plasma
- RM-1457-AEC Grüneisen's Law and the Fusion Curve at High Pressure
- RM-1682-AEC Calculation of Fields on Plasma Ions by Collective Coordinates
- RM-1704 Amplitudes of Thermal Vibration at Fusion
- RM-1802-AEC The Correlation Energy of an Electron Gas at High Density
- RM-1823-AEC The Specific Heat of a Degenerate Electron Gas at High Density
- RM-1865-AEC The Characteristic Energy Loss of Electrons Passing through Metal Foils—II:
Dispersion Relation and Short Wave Length Cutoff for Plasma Oscillations
- RM-2010-AEC Free-free Gaunt Factors
- RM-2447-AEC The Emissive Power of Ionized Hydrogen Gas
- RM-2580-AEC Fermi-Dirac Averages of the Free-free Hydrogenic Gaunt Factor
- RM-2798-AEC The Strength of Underground Cavities of Spherical and Spheroidal Geometry
- RM-3050-PR Collision Damping of Plasma Oscillations
- P-644-AEC The Lindemann and Grüneisen Laws
- P-650-AEC Grüneisen's Law and the Fusion Curve at High Pressure
- P-663-AEC Stark Fields from Ions in a Plasma
- P-849-AEC Calculation of Fields on Plasma Ions by Collective Coordinates
- P-985-AEC The Correlation Energy of an Electron Gas at High Density
- P-988-AEC The Specific Heat of a Degenerate Electron Gas at High Density
- P-1002-AEC The Characteristic Energy Loss of Electrons Passing through Metal Foils—II:
Dispersion Relation and Short Wave Length Cutoff for Plasma Oscillations
- P-2441 Satellite Charge-up in the Outer Van Allen Belt
- T-90 Unified Dynamics and Thermodynamics of a Thermal Plasma
- T-96 Mollier Enthalpy-Entropy Charts for High-temperature Plasmas
- T-99 Equilibria in a Thermal Plasma Composed of $\text{C} + \text{H}_2$ and $\text{C} + 2\text{H}_2$ in a Temperature Range from 5000°K to $50,000^\circ\text{K}$ at a Total Pressure of 1 Bar
- T-100 Equilibria in $\text{C} + \text{H}_2$ and $\text{C} + 2\text{H}_2$ Systems at Temperatures between 1000°K and 6000°K
- T-101 Radiation of Plasma in a Magnetic Field

ATOMIC PHYSICS: SOLID STATE

- RM-4 Thermodynamic Properties of Metals
- RM-261 On the Thermodynamics of Solids: Critical Discussion of the Debye and Raman Theories with Applications
- RM-1457-AEC Grüneisen's Law and the Fusion Curve at High Pressure
- RM-1496-AEC The Equation of the Fusion Curve
- RM-1511-AEC Abstract Compendium on Theoretical Equation of State for Solids
- RM-1556-AEC The Grüneisen Parameter for an Einstein Solid and under Finite Strain
- RM-1704 Amplitudes of Thermal Vibration at Fusion
- RM-2592 The Possible Use of Atomic Nuclei as a Direction Reference in Inertial Space
- P-650-AEC Grüneisen's Law and the Fusion Curve at High Pressure
- P-667 Temperature Behavior of the Thomas-Fermi-Statistical Model for Atoms
- P-682-AEC The Equation of the Fusion Curve
- P-747-AEC The Grüneisen Parameter for an Einstein Solid and under Finite Strain
- P-854 Amplitudes of Thermal Vibration at Fusion
- P-882-AEC A Mathematical Model of the Phenomenon of Radioactive Fallout
- P-894 Variation of the Amplitude of Thermal Vibration on the Fusion Curve

- P-943 Impurity-induced Localized Modes of Lattice Vibration in a Diatomic Chain
- P-1482 On the Possibility of an Energy Gap in the Spectrum of a Degenerate Fermi Liquid
- P-2304 Nuclear Gyros
- T-34 Shock Waves in Isotropic Elastic Media

ATOMIC PHYSICS: THERMODYNAMICS

- RA-15088 A Table of Vibrational Contributions of a Harmonic Oscillator to Thermodynamic Functions
 - R-149 The Composition and Thermodynamic Properties of Air at Temperatures from 500° to 8000°K and Pressures from 0.00001 to 100 Atmospheres
- RM-4 Thermodynamic Properties of Metals
- RM-261 On the Thermodynamics of Solids: Critical Discussion of the Debye and Raman Theories with Applications
- RM-421 The Thermodynamic Properties of Silicon in the Solid, Liquid, and Gaseous States
- RM-436 Tables of Contributions to Thermodynamic Properties Due to Gas Imperfection
 - RM-438 Summary Report: Cyclic Heat-transfer Studies with Gases
- RM-442 Thermodynamic Properties of Real Gases for Use in High-pressure Problems
- RM-524 Working Tables of Thermodynamic Functions and Equilibrium Constants for Silicon, SiO, and SiO₂
- RM-1543 Equilibrium Composition and Thermodynamic Properties of Air to 24,000°K
- RM-1650 Approximate Thermodynamic Properties of Compressed Hydrogen Gas from 5000° to 12,000°K
- RM-1704 Amplitudes of Thermal Vibration at Fusion
- RM-1793-AEC Thermodynamic Properties of Mixtures on the Statistical Model
- RM-1801 A Linear Programming Model of the Gaseous Diffusion Isotope-separation Process
- RM-1823-AEC The Specific Heat of a Degenerate Electron Gas at High Density
 - RM-2292 Thermodynamic Properties of Carbon Dioxide to 24,000°K with Possible Application to the Atmosphere of Venus
- RM-2328 Additional Values for the Equilibrium Composition and Thermodynamic Properties of Air
- P-474-AEC Thermodynamics of the Thomas-Fermi Atom at Low Temperatures
 - P-840 Properties of the Shock Transition at Low Temperature
 - P-927-AEC Thermodynamic Properties of Mixtures on the Statistical Model
 - P-988-AEC The Specific Heat of a Degenerate Electron Gas at High Density
 - P-1059 Chemical Equilibrium in Complex Mixtures
 - P-1060 A Linear-programming Approach to the Chemical Equilibrium Problem
 - P-1073-AEC On the Compressibilities of Simple Metals
- P-1286 Chemical Thermodynamics in Rocket Nozzles
 - P-1899 The Separation of Uranium Isotopes by Gaseous Diffusion: A Linear-programming Model
- P-2056 Solving the Chemical Equilibrium Problem Using the Decomposition Principle
 - P-2218-1 Thermodynamic Properties of Carbon Dioxide to 24,000°K
 - T-90 Unified Dynamics and Thermodynamics of a Thermal Plasma
 - T-96 Mollier Enthalpy-Entropy Charts for High-temperature Plasmas
 - T-99 Equilibria in a Thermal Plasma Composed of C + H₂ and C + 2H₂ in a Temperature Range from 5000°K to 50,000°K at a Total Pressure of 1 Bar
 - T-100 Equilibria in C + H₂ and C + 2H₂ Systems at Temperatures between 1000°K and 6000°K

ELECTRODYNAMICS

- RM-1027 On the Interaction of Scalar and Electrostatic Fields
- RM-1412-AEC Effect of Correlations on the Equation of State of an Electron Gas
- RM-1847-AEC Thomas-Fermi Equation of State for Dilute Gases
 - RM-1852 An Application of Superconductivity to Inertial Navigation
 - RM-2092-AEC Relativistic Oscillator Strengths
 - RM-2223-AEC The Free-free Gaunt Factor in an Ionized Medium
- RM-2271 Correlation Energy of a Degenerate Electron Gas
- RM-2820-PR Classical Electron Theory from a Modern Standpoint

PHYSICS—continued

ELECTRODYNAMICS—continued

- P-645 Radiation Patterns of Unsymmetrically Fed Prolate Spheroidal Antennas
- P-839 On the Principle of Invariant Imbedding and Propagation through Inhomogeneous Media
- P-976 On the Principle of Invariant Imbedding and Diffuse Reflection from Cylindrical Regions
- P-996 On the Principle of Invariant Imbedding and One-dimensional Neutron Multiplication
- P-1102 On the Principle of Invariant Imbedding and Neutron Transport Theory—I: One-dimensional Case
- P-1187 Fuel Cells: Current Problems and Potential Usefulness
- P-1380 Invariant Imbedding and Neutron Transport Theory: A Generalized Approach
- P-1390 Invariant Imbedding and Generalized Transport Theory: A Basic Stochastic Functional Equation
- P-1408 Invariant Imbedding and Neutron Transport Theory—III: Neutron-Neutron Collision Processes
- P-1471 Invariant Imbedding and Wave Propagation in Stochastic Media
- P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
- P-1523 Correlation Energy of a Degenerate Electron Gas
- P-1631 Magnetic Storms
- P-1645 An Approximation Method for Large-angle Scattering of High-energy Scalar and Vector Waves
- P-1726 Remarks on Auroral Isochasms
- P-1746 Some Consequences for Quantum Electrodynamics of an Essential Singularity at $\alpha = 0$
- P-1753 Geomagnetic Control of Auroral Phenomena
- P-1797 Transport Theory and Invariant Imbedding
- P-1835 Invariant Imbedding and Neutron Transport Theory—V: Diffusion as a Limiting Case
- P-1861 Space Vehicle Power Plants
- P-1952 Dissipation Functions and Invariant Imbedding—I
- P-2014 Invariant Imbedding, Conservation Relations, and Nonlinear Equations with Two-point Boundary Values
- P-2035 Geomagnetism in Relation to Aeronomy
- P-2070 The Effect of Interactions on Determination of Fermi Surfaces
- P-2071 Invariant Imbedding and the Reduction of Two-point Boundary Value Problems to Initial Value Problems
- P-2122 Invariant Imbedding and Variational Principles in Transport Theory
- P-2271 A New Approach to the Quantum Electrodynamics of a Medium
- P-2431 Spin Susceptibility of Normal Fermion Systems
- RAT-9 Increase in Sensitivity of Amplifiers and Mixers in the Meter and Decimeter Wave Range
- RAT-13 Propagation of Long Waves around the Earth
- T-64 On Amplitude and Phase Pulsations of a Wave Propagating in a Slightly Inhomogeneous Atmosphere
- T-101 Radiation of Plasma in a Magnetic Field

GAS AND FLUID DYNAMICS

- RM-646 The Viscosity of Polar Gases
- RM-649 Calculation of the Viscosity of Gas Mixtures
- RM-819 Shock Wave Interaction, or the Velocity Effect in H.E. Rounds
- RM-848 Note on Directional Effects of Pressure Field of Moving Blast
- RM-1208-AEC Hydrogen Wave-functions
- RM-1363-AEC Numerical Solutions of Spherical Blast Waves
- RM-1435 A Similarity Solution for a Spherical Shock Wave
- RM-1713 Hypersonic, Nonviscous Flow around a Circular Disk Normal to the Stream
- RM-1965 A Calculation of the Blast Wave from a Spherical Charge of TNT
- RM-1974 Theoretical Solutions of Spherical Shock-tube Blasts

- RM-2077 Strong-shock Point-source Blast Wave in a Non-uniform Atmosphere
- RM-2091-AEC Hydrogenic Bound-free Gaunt Factors
- RM-2211 Reflection Factors for Normally Reflected Shocks in Air
- RM-2244 Heat Transfer in a Dissociating Gas
- RM-2292 Thermodynamic Properties of Carbon Dioxide to 24,000°K, with Possible Application to the Atmosphere of Venus
- RM-2490-1 Thermoelectric Powerplants Utilizing Contained Nuclear Explosions
- RM-2686-AEC Static Deformation of a Plastic Medium
- RM-2930-PR An Adiabatic-isothermal Nozzle
- RM-2931-PR The Structure of a Shock Wave in Air Taking Account of the Kinetics of Chemical Reactions
- RAOP-2 A Simplified Method for Computing the Equilibrium Composition of Gaseous Systems
- P-99 A Comparative Study of the Temperature Gradients Produced by Various Thermogenic Agents
- P-452 Numerical Solution of a Spherical Blast Wave
- P-571-AEC Numerical Solutions of Spherical Blast Waves
- P-633 A Similarity Solution for a Spherical Shock Wave
- P-695 Calculation of Hydrofoil Sections from Prescribed Pressure Distributions
- P-746 A New Approach to Penetration Mechanics
- P-785 The Impact Theory of the Origin of Lunar Craters
- P-832 The Nature of Axisymmetric Wave Fields in Elastic Solids
- P-836 The Impact of Large Meteorites
- P-840 Properties of the Shock Transition at Low Temperature
- P-930 Hypersonic, Nonviscous Flow around a Circular Disk Normal to the Stream
- P-975 A Calculation of the Blast Wave from a Spherical Charge of TNT
- P-1237 Experiments on Circular Arc and Flat Plate Hydrofoil in Noncavitating and Full Cavity Flows
- P-1395 Piston Theory Applied to Strong Shocks and Unsteady Flow
- P-1498 Surface Displacements in an Elastic Half-space
- P-1505 Dilatational Surface Waves in an Elastic Half-space
- P-1695 Some Interior Problems of Hydromagnetics
- P-1745 Linearized Theory of Cavity Flow in Two Dimensions
- P-1813 The Upper Atmosphere as Observed with Rockets and Satellites
- P-1875 Effect of a Transverse Magnetic Field on the "Escape Speed" of a Conducting Fluid
- P-1876 Upper Atmosphere Studies
- P-1920 A Comparison of Hydrodynamic and Electrostatic Forces on Cloud Droplets
- P-1933 Numerical Calculations of Blast Waves
- P-1960 Some Electrostatic Cloud-droplet Collision Efficiencies
- P-2008 One-dimensional Expansion of a Finite Mass of Gas into Vacuum
- P-2046 On the Problem of Ballistic Missile Defense
- P-2121 Calculations of Cloud Electrification Based on a General Charge Separation Mechanism
- P-2141 Similarity Solution for Cylindrical Magnetohydrodynamic Shock Waves Produced by a Line Current Which Increases Linearly with Time
- P-2244 Ionization Trails
- P-2293 Magnetically Driven Shock Waves
- P-2318 Analytic Methods and Approximations of MHD Problems
- P-2345 Recalculations of Cloud Electrification Based on a General Charge-separation Mechanism
- P-2350-1 Munk Integrals for Fully Cavitated Hydrofoils
- T-34 Shock Waves in Isotropic Elastic Media
- T-56 The Fluid Half Space under a Mechanical Influence on Its Surface (Two-dimensional Problem)
- T-57 On Certain Unsteady Motions of a Compressible Fluid
- T-59 The Elastic Half Space under a Mechanical Disturbance of Its Surface (Two-dimensional Problem)
- T-138 Sublimation near the Stagnation Point of an Axisymmetrical Blunt Body
- T-145 On the Analysis of Heat and Mass Transfer in Binary Gas Mixtures

PHYSICS—continued

MATHEMATICAL PHYSICS

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-1203-AEC Polynomial Approximations to Neutron-Deuteron Differential Angular Cross Sections
- RM-2288 Invariant Imbedding and Wave Propagation in Stochastic Media
- RM-2317 On One-dimensional Neutron Multiplication
- RM-2617 Geological Covering Materials for Deep Underground Installations
- RM-2643 Oblateness Perturbations of Near-earth Satellites
- RM-2693 Neutron Branching Processes
- RM-2859-PR New Directions of Research in the Theory of Differential Equations
- RM-2917-PR Estimates of Critical Dimensions of Spherical and Slab Reactors
- RM-2924-PR Some Aspects of Quasilinearization
- RM-3027-PR A Complete Solution of the X and Y Equations of Chandrasekhar
- RM-3031-PR On a Mechanical Interpretation of the Null Geodesics in Static Einstein-Riemann Spaces
- RM-3039-PR On the Characterization of Contemporaneous and Born Rigid Motions and the Questions of Their Equivalence
- RM-3092-PR Augmentation Analysis of the Einstein Gravitational Field
- RM-3113-PR Some Numerical Results Using Quasilinearization for Nonlinear Two-point Boundary Value Problems
- P-1102 On the Principle of Invariant Imbedding and Neutron Transport Theory—I: One-dimensional Case
- P-1113 Random Walk, Scattering, and Invariant Imbedding—I: One-dimensional Discrete Case
- P-1239 Invariant Imbedding, Wave Propagation, and the WKB Approximation
- P-1252 Invariant Imbedding and Neutron Transport Theory—II: Functional Equations
- P-1482 On the Possibility of an Energy Gap in the Spectrum of a Degenerate Fermi Liquid
- P-1484 A General Theorem Concerning the Stability of a Particular Non-Newtonian Fluid
- P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
- P-1529 Functional Equations, Wave Propagation, and Invariant Imbedding
- P-1563 A Mathematical Model for Multiplication by Binary Fission
- P-1613 Dynamic Programming, Invariant Imbedding, and Two-point Boundary Value Problems
- P-1614 Invariant Imbedding, Random Walk, and Scattering—II: Discrete Versions
- P-1681 Some Comments on the Wave Propagation Study Group
- P-1784-AEC Radial Distribution Functions from the Born-Green Integral Equation
- P-1797 Transport Theory and Invariant Imbedding
- P-1835 Invariant Imbedding and Neutron Transport Theory—V: Diffusion as a Limiting Case
- P-1858 Invariant Imbedding and Mathematical Physics—I: Particle Processes
- P-1898 On the Stability of Solutions of the Linearized Plasma Equation
- P-1930 Perturbation and Renormalization—I
- P-1952 Dissipation Functions and Invariant Imbedding—I
- P-1985 Neutron Branching Processes
- P-2014 Invariant Imbedding, Conservation Relations, and Nonlinear Equations with Two-point Boundary Values
- P-2055 A Series Expansion for $\log I_0(z)$
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
- P-2071 Invariant Imbedding and the Reduction of Two-point Boundary Value Problems to Initial Value Problems
- P-2079 Mie Scattering with Complex Index of Refraction
- P-2100 An Affine Field Description of Gravitation Electromagnetism and Matter
- P-2122 Invariant Imbedding and Variational Principles in Transport Theory
- P-2130 Dynamic Programming, Fermat's Principle, and the Eikonal Equation
- P-2150 Criticality Estimates for Spheres and Slabs
- P-2163 On the Fundamental Equations of Invariant Imbedding—I

- P-2190 A Note on an Inverse Problem in Mathematical Physics
- P-2202 Invariant Imbedding and Random Walk
- P-2211 Principles of Invariance in Transport Theory
- P-2253-1 Estimates of Critical Dimensions of Spherical and Slab Reactors
- P-2268 On a New Computational Solution of Time-dependent Transport Processes—I: One-dimensional Case
- P-2341 Wave Branching Processes and Invariant Imbedding—I
- P-2379 Entropy and Conjugacy
- T-140 Calculation of the Heating of Two-layer Plates

MISCELLANEOUS

- R-389-PR Distribution of the Intensity and Polarization of the Diffusely Reflected Light over a Planetary Disk
- RM-255 Experimental Program
- RM-689 Empirical Determination of Noise Spectra
- RM-1416-AEC Atomic Energy Levels for the Thomas-Fermi and Thomas-Fermi-Dirac Potential
- RM-1420-AEC Solutions of the Temperature-perturbed Thomas-Fermi Equation
- RM-1453-AEC Relativistic and Non-relativistic Energy Levels in Uranium
- RM-1537-AEC Crystal Structures and Atomic Volumes of the Elements
- RM-1793-AEC Thermodynamic Properties of Mixtures on the Statistical Model
- RM-1802-AEC The Correlation Energy of an Electron Gas at High Density
- RM-1823-AEC The Specific Heat of a Degenerate Electron Gas at High Density
- RM-1865-AEC The Characteristic Energy Loss of Electrons Passing through Metal Foils—II: Dispersion Relation and Short Wave Length Cutoff for Plasma Oscillations
- RM-2456-AEC Probing the Earth with Nuclear Explosions
- RM-2492 Survey of Radiometric Quantities and Units
- RM-2696-AEC Power Recovery from the Kilauea Iki Lava Pool
- RM-2740 D-layer Ionization Loss Rates
- RM-3096-PR Idealized Sheath Theory and Satellite Charge-up in the Van Allen Region
- P-236 On the Evaluation of Noise Samples
- P-359 Constant-strain Waves in Strings
- P-488 W.K.B. Approximation through the Turning Point
- P-500 A Note on the Relativistic Thomas-Fermi Atom Model
- P-520-AEC Solution of the Temperature-perturbed Thomas-Fermi Equation
- P-523 A Review of Fourier Analysis and Autocorrelation
- P-532 Relationship between the Masses and Magnitudes of Small Meteoroids
- P-542 Quantitative Estimate of Frequency and Mass Distribution of Dust Particles Causing the Zodiacal Light Effect
- P-585-AEC Atomic Energy Levels for the Thomas-Fermi and Thomas-Fermi-Dirac Potential
- P-591-AEC Solutions of the Temperature-perturbed Thomas-Fermi Equation
- P-638 A Study of the Structure of the Ionosphere
- P-656 Numerical Solutions of the Thomas-Fermi Statistical Model
- P-749 The Power Spectrum of the Turbulent-scattered Field
- P-927-AEC Thermodynamic Properties of Mixtures on the Statistical Model
- P-985-AEC The Correlation Energy of an Electron Gas at High Density
- P-988-AEC The Specific Heat of a Degenerate Electron Gas at High Density
- P-1002-AEC The Characteristic Energy Loss of Electrons Passing through Metal Foils—II: Dispersion Relation and Short Wave Length Cutoff for Plasma Oscillations
- P-1073-AEC On the Compressibilities of Simple Metals
- P-1266-AEC Approximate Compressibilities of Elements on the Statistical Model
- P-1433 Some Elementary Facts of Relativity
- P-1482 On the Possibility of an Energy Gap in the Spectrum of a Degenerate Fermi Liquid
- P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
- P-1659 An Improved Solution for the Motion of Bodies in Free Fall
- P-1706 On the Quantization of Meson Mass
- P-1767 The Consistency of Quantum Field Theories
- P-1967 Cryogenic Gyros

PHYSICS—continued

MISCELLANEOUS—continued

- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts
- P-2054 A First Estimate of Initial Surface Motions Produced by an Underground Explosion
- P-2101 Theory of Auroral Morphology
- P-2111-AEC Probing the Earth with Nuclear Explosions
- P-2160 Positive Ions in the Lower D Region
- P-2215 An Extension of the Karal-Keller Asymptotic Theory of Wave Propagation and Its Application to Explosive Sources
- P-2270 Boundary Effects on the Energy Loss of Charged Particles
- P-2271 A New Approach to the Quantum Electrodynamics of a Medium
- P-2304 Nuclear Gyros
- P-2365 Wave-induced Motions of a Large Rocket Vehicle Drifting in a Vertical Attitude
- P-2399 Detection of Nuclear Explosions
- P-2406 World Magnetic Survey: Introductory Remarks
- P-2434 The Problem of Detecting Nuclear Explosions
- T-21 On the Spin and the Structure of Electrons
- T-39 Diffusion of Meteoric Trails

PHYSIOLOGY

- RM-1956 Note on the Sr⁹⁰ Hazard
- RM-2409 Note on the Strontium-90 Fallout
- RM-2500 An Evaluation of the Human Retinal Burn Problem Arising from Atomic Detonations
- RM-2519 A Mathematical Model of the Human External Respiratory System
- RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-58 Physiological Damage Due to Microwaves
- P-81 An Electromagnetic Blood Flow Meter
- P-99 A Comparative Study of the Temperature Gradients Produced by Various Thermogenic Agents
- P-122 Effects of Intense Microwave Radiation on Living Organisms
- P-249 The Current and Predicted Status of Engineering Techniques in Relation to Human Travel at Upper Altitudes
- P-302 Emotional Stress and Air War
- P-1143 Certain Fundamental Approaches to the Use of Biological Material in Space Devices
- P-1304 Certain Ecological Aspects of a Closed Lunar Base
- P-1309 Internal Environment of Manned Space Vehicles
- P-1406 Experiments in Interplanetary Biomigration and Space Contamination
- P-1577 Environmental Requirements for Extended Occupancy of Manned Satellites
- P-1811 A Mathematical Model of the Human External Respiratory System
- P-1911 Some Mathematical Aspects of Optimal Predation in Ecology and Boviculture
- P-2044 Numerical Investigations of Chemotherapy Models
- P-2048 A Mathematical Model of the Chemistry of the External Respiratory System
- P-2102-RC Mathematical Models of Chemotherapy
- P-2139 An Application of Mathematical Programming to Physiology: The Human Respiratory System
- P-2154 New Version of a Two-organ Chemotherapy Model
- P-2191 Some Experiments and Problems in Mathematical Biology
- P-2300 Mathematical Experimentation and Biological Research
- P-2303 From Chemotherapy to Computers to Trajectories
- P-2307 Simulation of a Biological System on an Analog Computer
- P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint

- RAT-5 Equipment Used To Determine the Effect of Sound and Oscillations on the Human Body
- T-17 The Possible Spread of Radioactive Infection by the Fission Products of U^{235}

PROPULSION—See also Aircraft, Missiles, Nuclear Studies, and Space Flight

AIR-BREATHING ENGINES

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes: Turbofan Engine Supplement
- RM-66 A Method for the Evaluation of Ramjet Fuels
- RM-106 Gas Turbine Cycle Analysis by Means of Entropy Changes and Polytrropic Component Efficiencies
- RM-417 Calculation of Specific Impulse and Other Rocket Performance Characteristics
- RM-432 An Approximate Method for the Determination of Maximum Ramjet Impulse
- RM-763 A Simple Method for Calculating the Thrust of Turbojet Engines with Under-expanded, Convergent Exhaust Nozzles
- RM-838 Tabulated Results of Hot Gas Generator Cycle Calculations
- RM-1009 Turboprop Engine Characteristics
- RM-1039 Performance Analysis Methods for the Twin-spool, High-pressure Ratio, Turbojet Engine
- RM-1179 Preliminary Study of Turbojets for Mach 2.75
- RM-1205 Approximate Methods for Determining the Performance of Gas Turbine Engines at Off-design Conditions
- RM-1571 The Significance of Major Cycle Variables on Turbojet Engine Performance at Mach 3.0
- RM-1615 Basic Supersonic Ramjet Point-design Performance
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RAOP-1 Analysis and Performance of the Ramjet Engine
- P-60 The Simulation of Combustion Models in Wind Tunnels
- P-1214 A Study of Turbojet Engine Weight
- P-1506 Performance Analysis of Plug Nozzles for Turbojet and Rocket Exhausts
- P-1519 A Consideration of Fuels for Future Air Transportation Systems

FUELS

- RA-15042 Propellants for Supersonic Vehicles: Boron Compounds
- RA-15044 Propellants for Supersonic Vehicles: Liquid Oxygen
- RA-15046 Propellants for Supersonic Vehicles: Hydrogen Peroxide
- RA-15047 Propellants for Supersonic Vehicles: Liquid Fluorine
- RA-15048 Propellants for Supersonic Vehicles: Halogen Fluorides
- RA-15073 Eighth Quarterly Report—App. I: Materials, Fuels, and Combustion Project
- RA-15079 Economic Survey: The Potential Production of Anhydrous Hydrazine, Propellant for Supersonic Vehicles
- R-121 Economic Survey: The Potential Availability of Ammonia, Nitric Acid, and Nitrogen Tetroxide, Propellants for Supersonic Vehicles
- R-124 Economic Survey: The Potential Production of Liquid Fluorine, Chlorine Trifluoride, and Other Fluorine Compounds, Propellants for Supersonic Vehicles
- R-127 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—I: Fuels
- R-129 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—II: Oxidizers
- R-156 Economic Survey: The Potential Production of Diborane, Pentaborane, and Aluminum Borohydride, Propellants for Supersonic Vehicles
- R-196 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—III: Products of Combustion
- RM-66 A Method for the Evaluation of Ramjet Fuels
- RM-246 A Study To Determine the Flight Paths Which Require Minimum Time and Minimum Fuel for a Typical Present-day Interceptor

PROPULSION—continued

FUELS—continued

- RM-267 Illustrative Example of Application of Koopmans' Transportation Theory of Scheduling Military Tanker Fleet
- RM-273 A Compilation of Physical and Chemical Data Pertaining to Self-igniting Fuels for Ramjet Propulsion
- RM-417 Calculation of Specific Impulse and Other Rocket Performance Characteristics
- RM-432 An Approximate Method for the Determination of Maximum Ramjet Impulse
- RM-504 Behavior of Commercial Hydrazine in Contact with Various Materials
- RM-519 Hydrazine Synthesis and Dehydration
- RM-2400 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—I: Hydrogen
- RM-2401 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—II: Ammonia
- RM-2402 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—III: Water
- RM-2403 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—IV: Lithium Hydride
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RAOP-26 The Application of the Schlieren Method to the Quantitative Measurement of Mixing Gases in Jets
- RAOP-27 Estimated Thermodynamic Functions of Free Radicals in Combustion Gases
- RAOP-28 The Automatic Sampling of Gases at High Temperatures and Pressures
- P-1519 A Consideration of Fuels for Future Air Transportation Systems
- P-1558 A Layman's Review of Propulsion and Propellants for Space Flight
- P-1639 Sources, Availability, and Estimated Costs of Propellants
- P-1954 The Russian Literature on Rocket Propellants
- P-2095 Liquid Propellant Rockets—1960

MISCELLANEOUS

- RA-15027 Satellite Rocket Powerplant
- RM-2807-PR A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—V: Methane
- RM-3053-PR Recent Soviet Advances in Aerospace Technology
- P-210 The Generalized Approach to the Selection of Propulsion Systems for Aircraft
- P-1429 Propulsion Fundamentals
- P-1558 A Layman's Review of Propulsion and Propellants for Space Flight
- P-1891 Powerplants for Atmospheric and Surface Vehicles on Mars
- P-1908 Propulsion Requirements for Rendezvous in Orbit
- RAT-1 Optimum Shapes for Axially Symmetrical Supersonic Thrust Nozzles
- T-60 The Theory of Mixture Preparation in Continuously Burning Combustion Chambers (Parts I and II)

NUCLEAR DEVICES

- RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- RM-2280 A Correlation of the Critical Conditions for Homogeneous Bare Reactors
- RM-2400 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—I: Hydrogen
- RM-2401 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—II: Ammonia
- RM-2402 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—III: Water
- RM-2403 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—IV: Lithium Hydride
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RM-2807-PR A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—V: Methane

- P-1519 A Consideration of Fuels for Future Air Transportation Systems
- P-1651 Augmentation of Nuclear-rocket Specific Impulse through Mechanical-Electrical Means
- P-1713 A Discussion of the Correlation of Critical Conditions for Bare Homogeneous Reactors

ROCKETS

- RA-15039 Ceramic Materials Research for Aircraft and Rocket Vehicles
- RA-15056 Ceramic Materials Research in the United Kingdom for Aircraft and Rocket Vehicles
- R-117 An Evaluation of Ceramic Materials for Aircraft and Rocket Vehicles
- R-121 Economic Survey: The Potential Availability of Ammonia, Nitric Acid, and Nitrogen Tetroxide, Propellants for Supersonic Vehicles
- R-124 Economic Survey: The Potential Production of Liquid Fluorine, Chlorine Trifluoride, and Other Fluorine Compounds, Propellants for Supersonic Vehicles
- R-127 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—I: Fuels
- R-129 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—II: Oxidizers
- R-196 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—III: Products of Combustion
- R-203 Chemical Kinetics and Rocket Nozzle Design
- RM-274 Determination of Expected Coverage and of Expected Damage: Single Bomb of Large Lethal Area
- RM-417 Calculation of Specific Impulse and Other Rocket Performance Characteristics
- RM-1718 The Optimization of Nozzle Area Ratio for Rockets Operating in a Vacuum
- RM-1796 On the Optimization of Two-stage Rockets
- RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- RM-2276 Minimal Impulse Requirements for Disorbiting Satellites
- RM-2300-RC The Rocket Performance Computer
- RM-2400 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—I: Hydrogen
- RM-2401 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—II: Ammonia
- RM-2402 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—III: Water
- RM-2403 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—IV: Lithium Hydride
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RM-2539 Vehicles for Exploration on Mars
- RAOP-19 Calculation of the Composition of Multicomponent Propellant Gases
- P-128 Kinetic Study of the Thermal Decomposition of Hydrazine Vapor in a Silica Vessel
- P-178 Heat Recovery and Maximum Thermodynamic Efficiency in a Rocket
- P-237 Chemical Kinetics and Rocket Nozzle Design
- P-1004 On the Optimization of Two-stage Rockets
- P-1112 The Optimization of Nozzle Area Ratio for Rockets Operating in a Vacuum
- P-1286 Chemical Thermodynamics in Rocket Nozzles
- P-1479 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- P-1506 Performance Analysis of Plug Nozzles for Turbojet and Rocket Exhausts
- P-1542 Suitability of Solid and Liquid Rocket Engines for Placing Manned Satellites on Orbit
- P-1651 Augmentation of Nuclear-rocket Specific Impulse through Mechanical-Electrical Means
- P-1954 The Russian Literature on Rocket Propellants
- P-2095 Liquid Propellant Rockets—1960
- P-2187 An Optimum Thrust Control Problem

PSYCHOLOGY

AUTOMATA

- RM-671 Neural Nets for "Toad T1"
- RM-678 Some Notes for Simple Pavlovian Learning
- RM-704 Representation of Events in Nerve Nets and Finite Automata

PSYCHOLOGY—continued

AUTOMATA—continued

- RM-744 Flicker and Fusion in a Hypothetical Device for Light-intensity Discrimination
- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography
- RM-3007-PR Studies in the Theory of Computational Algorithms—1: Formalization, Computability, Representation, and Analysis Problems
- P-296 Hypothetical Robots and the Problem of Neuroeconomy
- P-316 Even in Memoryless Robots There Is No Small Number of Central Cells Sufficient for All Input-Output Specifications
- P-378 Sense Data in Robots and Organisms
- P-620 The Chess Machine: An Example of Dealing with a Complex Task by Adaptation
- P-1319 Chess-playing Programs and the Problem of Complexity
- P-1820 An Experiment in Chess Playing by Machine
- P-2257 GPS: A Program That Simulates Human Thought

LABORATORY MAN-MACHINE STUDIES

- RM-890 The Systems Research Laboratory and Its Program
- RM-922 Observations and Comments on the Organization Studies of the Systems Research Laboratory
- △● RM-1163 Communication and Learning in Task-oriented Groups
- RM-1916 Data for Testing a Model of Organizational Behavior
- RM-2506 The Simulation of Human Thought
- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography
- P-443 Systems Research and Personnel Management
- P-529 Observations on the Growth of Information-processing Centers
- P-587 Social Interaction
- P-653 A Transition Model Laboratory for Research on Cultural Change
- P-657 The Systems Research Laboratory and Its Program
- P-658 Description of the Air-defense Experiments—III: Data Collection and Processing
- P-659 Description of the Air-defense Experiments—II: The Task Environment
- P-660 Systems Behavior—II: The Developmental Process
- P-661 Description of the Air-defense Experiments—I: The Physical and Cultural Environments
- P-662 Systems Behavior—I: The Learning Process
- P-740 The Background and Implications of the Systems Research Laboratory Studies
- P-753 *Cogwheel*: A Film Story of Systems Research Laboratory's Activities
- P-802 A Theory of Organizational Behavior Deriving from Systems Research Laboratory Studies
- P-1074 Simulation in RAND's Systems Research Laboratory
- P-1075 Simulation in RAND's Logistics Systems Laboratory
- P-1202 The Systems Research Laboratory's Air-defense Experiments
- P-1634 Integration of Modelling and Simulation in Organizational Studies
- P-1680 Triangle: Man, Machine, Space
- P-1734 The Simulation of Human Thought
- P-1808 Simulation Techniques
- P-2086 Man-Machine Simulation Progress
- P-2127 The Use of Heuristic Programming in Management Science
- P-2166 Some Thinking about "System"
- P-2199 Four Types of Learning: A Phenomenological Analysis
- P-2221 Modeling Human Mental Processes
- P-2235 The Simulation of Verbal Learning Behavior
- P-2258 Why We Cannot Build "Thinking Machines" (At Least at Present)
- P-2310 The Allocation of Functions between Man and Machines in Automated Systems
- P-2311 Forgetting in an Association Memory
- P-2312 Computer Simulation of Human Thinking and Problem Solving
- P-2332 Motivational Problems in Human-Computer Operations
- P-2337 Human Factors in Systems Research

- P-2358 Performance of a Reading Task by an Elementary Perceiving and Memorizing Program
- P-2375 A Theory of the Serial Position Effect
- T-126 Comparison of Theoretically Possible and Actual Procedures Used in Problem Solving

MISCELLANEOUS

- RM-3011 Mechanisms Underlying Predictive Behavior for an Intelligent Machine
- P-447 Experiments on "The Cortical Correlate of Pattern Vision"
- P-708 The Psychologist in Interdisciplinary Research
- P-795 A Simple Model for the Production of the Normal Electroencephalogram
- P-987 Problem Solving in Humans and Computers
- P-1320 The Processes of Creative Thinking
- P-1742 A Variety of Intelligent Learning in a General Problem Solver
- P-1817 An Information Processing Theory of Verbal Learning
- P-1917 Psychological Inspection
- P-1946 On Programming a Highly Parallel Machine To Be an Intelligent Technician
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
- P-2114-1 Attitudes toward Intelligent Machines
- P-2156 Decisionmaking under Uncertainty and Problem Solving: A Gestalt Theoretical View-point
- P-2166 Some Thinking about "System"
- P-2170 Toward Intelligent Machines
- P-2199 Four Types of Learning: A Phenomenological Analysis
- P-2258 Why We Cannot Build "Thinking Machines" (At Least at Present)
- P-2276 Computer Simulation of Human Thinking
- P-2349 Experiments with a Heuristic Compiler
- P-2439 Comments on an Article by Chas. E. Osgood, "A Psychologist's Cure for the Arms Race"
- P-2442 The Resolution of Cognitive Conflict under Uncertainty: A Critique
- P-2444 Perception, Cognition and Science
- P-2472 Imbalance in Balance "Theory"
- RAT-5 Equipment Used To Determine the Effect of Sound and Oscillations on the Human Body
- T-143 A Probability Model of Perception

ORGANIZATION THEORY

- RM-544 A Translation of the Simon Employment Relationship Theory into the Kruskal-Newell Language
- RM-619 Formulating Precise Concepts in Organization Theory
- RM-709 Report of a Seminar on Organization Science
- RM-734 Prolegomena to a Theory of Organization
- RM-953 Some Group Interaction Models
- RM-1575 The Contextual Map
- P-219 A Comparison of Organization Theories
- P-234 On the Application of Servomechanism Theory in the Study of Production Control: A Study in the Theory of Organization
- P-266 The Uses and Limitations of Mathematical Models, Game Theory, and Systems Analysis in Planning and Problem Solution
- P-272 Some Practical Problems of the Alertness Indicator
- P-291 An Example in the Theory of Organization
- P-312 Testing Organization Theories
- P-850 Current Developments in Complex Information Processing
- P-965 A Display Technique for Planning
- P-1026 The Game-theoretical Approach to Organization Theory
- P-1043 Comments of the Sociology of Management
- P-1053 The Prospects of a Unified Theory of Organizations
- P-2273 The Application of Human Relations Research to Administration
- P-2362 On the Determination of Occupational Categories in an Organization

PSYCHOLOGY—continued

SLEEP-LEARNING

- △ ● RM-1222 Considerations for Research in a Sleep-learning Program
- RM-1442 Responses to Material Presented during Various Levels of Sleep
- RM-1444 The Nonrecall of Material Presented during Sleep
 - P-534 A Critical Review of the "Learn-While-You-Sleep" Studies
- P-565 Considerations for Research in a Sleep-learning Program
- P-618 Responses to Material Presented during Various Levels of Sleep
- P-619 The Nonrecall of Material Presented during Sleep
- P-655 The EEG, Consciousness, and Sleep

RADAR—See also Bombing, Countermeasures and Counter-countermeasures, Defense Studies, Electronic Environment Studies, Electronics, Guidance and Control, Infrared Studies, and Navigation

DETECTION THEORY

- RM-689 Empirical Determination of Noise Spectra
- RM-753 A Statistical Theory of Target Detection by Pulsed Radar: Mathematical Appendix
- RM-754 A Statistical Theory of Target Detection by Pulsed Radar
- RM-989-1 Some Factors Affecting the Performance of a Tracking Radar
- RM-1008 The "Double Threshold" Method of Detection
- RM-1217 Probability of Detection for Fluctuating Targets
 - RM-1238 Detection Range of an Active Radar Seeker
- RM-1491 Maximum Angular Accuracy of a Pulsed Search Radar
- RM-1643 On the Problem of Determining the Position of a Target with Constant Signal in the Presence of Circuit Noise or Chaff
 - RM-1719 Performance of the "Double-threshold" Radar Receiver in the Presence of Interference
 - RM-1770 On the Detection of Stochastic Signals in Additive Normal Noise—Part I
- RM-2625 Some Results on New Classes of Matched Filters
- RM-2953-PR On the Effectiveness of Search Algorithms Based on Samples of Controlled Duration (Sequential Detection)
- RM-2987-PR Approximate Band-pass Limiter Envelope Distributions
- RM-3090-PR Interpolation and Extrapolation of Stationary Random Sequences
- P-1185 A Method of Computing the Inherent Accuracy with Which a Time Delay Can Be Estimated
- P-1221 Approximate Evaluation of an Expression Arising in the Theory of Time-delay Estimation
 - P-1585 Masers and Irasers
 - P-1976 The Far-field Back-scattering from a Concave Corner of a Body of Revolution
 - P-2079 Mie Scattering with Complex Index of Refraction
 - P-2301-1 Approximations of Kth Order to Coherent Detection
 - P-2407 Probability and Statistics in Systems Work
 - P-2423 Sequential Detection in Radars with Multiple Resolution Elements
 - P-2487 The Design of a Sequential Test for the Detection of Known Signal in Normal Nonwhite Noise
 - P-2498 Some Simple Examples of Singular Detection of Continuous Signals in Noise

MISCELLANEOUS

- RM-130 A Note on Vacuum Tube Life
- RM-262 Limitations of Focused Aperture Antennas
- RM-673 Flight Test of ASR-1 Radar at Low Altitudes
- RM-989-1 Some Factors Affecting the Performance of a Tracking Radar
- RM-1969 Radioactive Contamination from a Multibomb Campaign

- RM-2375 Analysis of the "Delay and Comparison Circuit" for Radar Receivers in the Presence of Interference
- RM-2467 Angular Accuracy of a Phased Array Radar
- RM-2953-PR On the Effectiveness of Search Algorithms Based on Samples of Controlled Duration (Sequential Detection)
 - P-745 Maximum Angular Accuracy of a Pulsed Search Radar
 - P-1353 General Description of a Cooperative Anticollision System for Aircraft
 - P-1629 The Advantages of Functional Packaging of Electronic Equipment
- P-1750 Radar Signal Density Predictions and Measurements
- P-1862 The Resolvability of Point Sources
 - P-1973 Dynamic Programming, Sequential Estimation, and Sequential Detection Processes
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
 - P-2027 Angular Accuracy of a Phased Array Radar
 - P-2046 On the Problem of Ballistic Missile Defense
 - P-2186 The Compression of Finite Discrete Messages
 - P-2407 Probability and Statistics in Systems Work
 - P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options
 - P-2522 Western Electronic Show and Convention (WESCON), San Francisco, California, 1961

RADIOLOGICAL WARFARE—See Nuclear Studies, Physiology, and Targets

RECONNAISSANCE—See also Aircraft, Electronics, Missiles, and Operations

- RM-202 Total Reconnaissance with Total Countermeasures: Simplified Model
- RM-203 Solutions of a Special Reconnaissance Game
- RM-205 A Tactical Reconnaissance Model
- RM-208 Reconnaissance in Game Theory
- RM-241 Comparison of Reconnaissances
 - RM-517 Expected Results of a Bombing Strike, Including Reconnaissance
 - RM-787 A Simplified Study of Reconnaissance in Strategic Bombing Campaigns
 - RM-1158 Image Brightness Intensifiers
- RM-2110 Wide-band Magnetic Tape Recorder
- RM-2183 A Photographic System for Close-up Lunar Exploration
 - P-106 Total Reconnaissance with Total Countermeasures: Simplified Model
- P-1017 Generalized Analysis of Aerial Campaigns against Strategic Targets
 - P-1402 Satellite Weather Reconnaissance
 - P-1446 Multiple Image Printing for Planetary Photography
 - P-1671 Lunar Exploration by Photography from a Space Vehicle
 - P-1707 Observation Satellites: Problems, Possibilities, and Prospects
 - P-1718 Introduction to Photographic Instrumentation Engineering
 - P-1892 How Good Is the Lunik III Moon Photography?
- P-1895 The Evaluation of the Effect of the Environment on a Complex Operation
 - P-1969 Analysis of Possible Lunik III Picture Hoax
 - P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
 - P-2030 On Style in Research and Development

RELIABILITY—See also Aircraft, Electronics, and Missiles

- R-358 Automatic Checkout Equipment: Employment and Design Considerations
 - RM-10 An Experiment in Estimation
 - RM-87 Examination of Some Models of Failure of Equipment during Operation
- RM-260-1 Reliability of Progress Curves in Airframe Production
- RM-302 A Model for the Reliability of Complex Mechanisms
 - RM-958-1 A Field Trial of an Air Force Electronic Equipment Reliability Study Program
 - RM-1002 The Cost of Unreliability of Air Force Airborne Electronic Equipment as Represented by the Cost of Maintenance

RELIABILITY—continued

- RM-1058 Chain Reliability: A Simple Failure Model for Complex Mechanisms
- RM-1131 A Survey of the Current Status of the Electronic Reliability Problem
- RM-1257 Electronic Reliability and Supply Improvement Based on Failure Reporting and Presentation
- RM-1724 Some Physical Qualifications for Reliability Formulas
- RM-2149 Monte Carlo Models for Estimating Reliability: An Exploratory Analysis
- RM-2423 Use of Tolerance Limits in Missile Reliability Analysis
- RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
- RM-2508 The Measurement of Missile Reliability in Pre-launch Operating Environments
- RM-2514 Search Rules for Automatic Fault Location
- RM-2552 Approximate Confidence Limits for the Reliability of Series and Parallel Systems
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- RM-2735-PR Operational Criteria for the Design of Missile Readiness Testing Programs and Equipment
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography
- RM-2835-PR Operational and Human Factors in Planning Automated Man-Machine Checkout Systems
- P-183 An Analysis of Some Failure Data
- P-315 Reliability in Guided Missile Systems
- P-399 Complexity and Reliability in Electronic Equipment
- P-466 The Effect of Reliability of "Supervisory" Equipment on the Accuracy of a "Supervised" System
- P-545 Methodology for Reliable Failure Reporting from Maintenance Personnel
- P-573 Techniques in Putting Failure Data to Work for Management
- P-578 Machine Testing for Deviation of Data from a Poisson Distribution
- P-1008 Reliability and the Computer
- P-1139 Dynamic Programming and the Reliability of Multicomponent Devices
- P-1423 Use of Tolerance Limits in Missile Evaluation
- P-1521 Reliability Estimating by the Use of Random Sampling Simulation
- P-1623 Reliability, Quality Control, and Simulation
- P-1638 The Application of Random Sampling Simulation to Reliability Estimating
- P-1672 Measuring the Reliability of Equipments in Operating Environments
- P-1810 Measuring Missile Reliability in Prelaunch Environments
- P-1853 The Use of Reliability Estimates in the Design of Missile Prelaunch Checkout Equipment
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-1867 How Much Automaticity for Checkout Equipment
- P-1981 Support Resources
- P-1997 Optimizing a Prelaunch Checkout
- P-2053 The Effect of Maintenance and Reliability on the Operational Effectiveness of an Interceptor Squadron
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
- P-2153 Standards, Standardization, and Test Equipment
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness
- P-2317 A Malfunction-generation Model for a Manned Simulation of ICBM Logistics
- P-2319 Some Limitations of Automatic Test Equipment
- P-2401 Approximate Confidence Limits for the Reliability of Series and Parallel Systems
- P-2476 A Systems Engineering Approach to Reliability
- P-2538 A Game Theoretic Approach to Space Vehicle Prelaunch Activities Scheduling
- T-92 Theory and Applications of the Notion of Complex Signal

SOCIAL AND POLITICAL SCIENCE—See also Communications

ASIAN STUDIES

- R-356 China Crosses the Yalu: The Decision To Enter the Korean War
- RM-411 Political Trends in Japan
- RM-1331 Changing Japanese Attitudes toward Atomic Weapons
- RM-1659 Production of Food Crops in Mainland China: Prewar and Postwar
- RM-1778-RC Economic Development and Mutual Security: Some Problems of U.S. Foreign Assistance Programs in Southeast Asia
- RM-1845 Leaders of Communist China
- RM-1893 The Growth of China's Scientific and Technical Manpower
- RM-1992 "Contradictions" in the Moscow-Peking Axis
- RM-2534 The Significance of Chinese Communist Treatment of Khrushchev's January 14 Speech on Strategy
- RM-2535-RC Observations on Contemporary Burma
- RM-2561 Communist Strategy in Laos
- RM-2595 The Chinese Genie: Peking's Role in the Nuclear Test Ban Negotiations
- RM-2619-RC Recent Communist Tactics in Indonesia
- RM-2636-RC The Lao Elite: A Study of Tradition and Innovation
- RM-2637-RC The Role of the Military in Indonesia
- RM-2657 The Chinese Communist Line on Neutralism
- RM-2768 The Indonesian Eight-year Over-all Development Plan
- RM-3077-PR Some Remarks on Scientific Achievement in Communist China
- P-194 The Lesser Evil
- P-1061-RC Comments Prepared for the Annual Meeting of the Association for Asian Studies, Panel Discussion of Economic Development in South Asia, Sheraton-Plaza, Boston, April 3, 1957
- P-1104 The Growth of China's Scientific and Technical Manpower
- P-1183 "Contradictions" in the Moscow-Peking Axis
- P-1419 Broken Gems and Whole Tiles: A Review Article
- P-1447 Dynamics of the Moscow-Peking Axis
- P-1452-RC Indonesian Images of Their National Self
- P-1514-RC The Role of Political Organizations in Indonesia
- P-1576-RC Burma's Foreign Policy and the Korean War: A Case Study
- P-1595-RC The Effect of Chinese Nationalist Military Activities in Burma on Burmese Foreign Policy
- P-1714 The Sino-Soviet Alliance: How Durable?
- P-1801 A Scientist's Notes on the Cold War
- P-1894 Communist China and Nuclear Warfare
- P-1950 The Chinese People's Republic and the Bomb
- P-1953 Sinkiang and Sino-Soviet Relations
- P-1987 Why Are the Chinese Nervous?
- P-2022 The Chinese Genie: Peking's Role in the Nuclear Test Ban Negotiations
- P-2026 The Chinese Communist Line on Neutralism
- P-2029 Conflict Resolution in the Sino-Soviet Alliance
- P-2059 The Korean War: Political Limitations
- P-2098 Moscow, Peking, and Japan: Views and Approaches
- P-2161 The Role of the Chinese in Lao Society
- P-2214 Laos: The Current Phase in a Cyclic Regional Revolution
- P-2229 General Nasution's Mission to Moscow
- P-2230-1 The Foreign Policy Uses of the Chinese Revolutionary Model
- P-2254 Current Communist Tactics in Indonesia
- P-2265 Armies in the Process of Political Modernization
- P-2313 The Indonesian Eight-year Over-all Development Plan
- P-2330 Laos in Strategic Prospective
- P-2347 Political Doctrines and Practical Politics in Southeast Asia
- P-2382-1 Communist China's Demands on the World

SOCIAL AND POLITICAL SCIENCE—continued

ASIAN STUDIES—continued

- P-2397 The Sino-Soviet Conflict over the Transition to Communism
- P-2478-1 Khrushchev's Attack on Albania and Sino-Soviet Relations
- P-2508 Japan and Her Soviet Neighbor during the Interwar Years: Japanese Images and Reactions
- P-2561 Some Comparisons between the Russian and Chinese "Models"
- P-2570 Sources of Turbulence in the New Nations
- P-2571 The Japanese Communists and Their Struggle for Power
- T-104 The Development of Chinese Communist Military Forces

BASIC STUDIES

- R-157 The Frequency of Mental Disease: Long-term Trends and Present Status
- R-308 Strategic Surrender: The Politics of Victory and Defeat
- R-335 Strategy in the Missile Age
- RM-161 Are the Cominform Countries Using Hypnotic Techniques To Elicit Confessions in Public Trials?
- RM-218 On Functions of Relations with Especial Reference to Social Welfare
- RM-291 Social Choice and Individual Values
- RM-388 Human Factors in Systems Analysis
- RM-455 The Use of Mathematical Models in the Measurement of Attitudes
- RM-1013 The Heritage of Douhet
- RM-1723 The Views of Corporation Executives on the Probable Effect of the Loss of Company Headquarters in Wartime
- RM-1842 Implications of Nuclear Weapons in Total War
- RM-1866 Strategic Air Power in World War II
- RM-1882 Deterrence
- RM-2218 The Anatomy of Deterrence
- RM-2224 The Meaning of Limited War
- RM-2472 On Motives for "Disarmament" Research
- RM-2510 Nuclear Weapons and Limited War
- P-70 The Conditional Expectancy of Mental Disease
- P-119 The American Soldier and the Sociology of Military Organization
- P-136 Institutional Vulnerability in Mass Society
- P-187 An Experimental Study of Ambiguity and Context
- P-190 A Book Review of Schlesinger's *Marx, His Time and Ours*
- P-287 The "Policy Sciences": Aspiration and Outlook
- P-302 Emotional Stress and Air War
- P-360 Attitudes toward the Use of Force
- P-367 Totalitarianism and the Future
- P-430 Sociological Aspects of the Information Process
- P-438 The Vulnerability of the United States to Enemy Attack: Elements of an Unclassified Research Program in the Social Sciences
- P-444 Military Implications of Nuclear Weapon Developments
- P-471 War and Peace
- P-497 Atomic Weapons and Ground Combat: Search for Organization and Doctrine
- P-527 Some Notes on the Evolution of Air Doctrine
- P-604 The Impact of Air Power on the International Scene, 1933-1940
- P-669 The Influence of Mass Destruction Weapons on Strategy
- P-720 Demographic Interaction Analysis and Its Bearing on Small Group Studies
- P-750 On Reducing Tension
- P-811 Nuclear Weapons and Changing Strategic Outlooks
- P-841 Strategy versus Tactics in a Nuclear Age
- P-889 Comments on Warfare in the Next Ten to Twenty Years
- P-896 Disarmament Failure and Weapons Limitations
- P-968 Scientific Progress and Political Science
- P-1092 The Worth of Principles of War

- P-1096 A Psychoanalytic Interpretation of Woodrow Wilson: A Book Review
- P-1111 Some Strategic Implications of the Nuclear Revolution
- P-1118 Implications of Nuclear Weapons in Total War
- P-1144 Deterrence
- P-1222 The Meaning of Limited War
- P-1225 Secular Trends in the Birth Ratio of Whites, by States, for the United States, 1870-1950
- P-1400 Disengagement
- P-1405 The Anatomy of Deterrence
- P-1458 A Rational Economic Model Approach to the Birth Rate
- P-1472 The Delicate Balance of Terror
- P-1572 Quantitative and Qualitative Approaches to Content Analysis
- P-1620 Nuclear Weapons and Limited War
- P-1649 The Gains to India from Population Control: Some Money Measures and Incentive Schemes
- P-1679-RC Some Observations on Political Gaming
- P-1747 Seven Fallacies about Central Africa
- P-1877 On the Value of Overseas Bases
- P-1917 Psychological Inspection
- P-1956 "Nth Countries" and Disarmament
- P-1965 Deterrence of Unlimited War: A Propositional Outline
- P-2000 The Violation of Arms Control Agreements: Deterrence versus Detection
- P-2025-2 Facts and Morals in the Arms Debate
- P-2042 A Public Opinion Game
- P-2220 Democratic Stability and Instability
- P-2230-1 The Foreign Policy Uses of the Chinese Revolutionary Model
- P-2265 Armies in the Process of Political Modernization
- P-2289 Utilization of Social Research in Shaping Policy Decisions
- P-2290 Punishment as Conflict Resolution
- P-2344 Prelude to Policy: Understanding
- P-2352 Concepts of Limited War: An Historical Approach
- P-2433 On Local War Doctrine
- P-2462-1 Science and Statecraft
- P-2482 Political Negotiation as a Process of Modifying Utilities
- P-2570 Sources of Turbulence in the New Nations
- T-79 The Role of Science and Technology in Modern War
- T-80 The Role of Science in Modern Warfare
- T-122 "Military Disengagement in Central Europe": A Speech by Bundestag Delegate Helmut Schmidt (SPD)

COMMUNICATIONS AND INTELLIGENCE

- R-285 International Communication and Political Opinion: A Guide to the Literature
- P-150 Totalitarian Communications as a Means of Control
- P-217 Methodology for Communications Research
- P-270 International Political Communication: Elite versus Mass
- P-372 Military Demonstration and Disclosure of New Weapons
- P-616 The Scientific Status of Propaganda Analysis
- P-617 Qualitative and Quantitative Procedures in Content Analysis
- P-665 The Role of Mass Communications during the Berlin Blockade
- P-779 Prediction of Political Action by Means of Propaganda Analysis
- P-788 The Soviet Approach to International Political Communication
- P-812 A Note on the Political Role of Mass Meetings in a Mass Communications Society
- P-1572 Quantitative and Qualitative Approaches to Content Analysis
- P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1869 Power: The Idea and Its Communication

DEFENSE STUDIES

- RM-2472 On Motives for "Disarmament" Research
- P-848-RC The Search for Decision in National Defense

SOCIAL AND POLITICAL SCIENCE—continued

DEFENSE STUDIES—continued

- P-1295 The Crisis in Military Affairs
- P-1313 Criminal Jurisdiction in Overseas Areas
- P-1472 The Delicate Balance of Terror
- P-1531 Some Complexities in Military Planning
- P-1549 "*The Cultural and Social Impact of an American Airbase upon an Urban French Community*. By Orvoell R. Gallagher": A Summary
- P-1566 The Place of Limited War in NATO Strategy
- P-1574 Surprise Attack and Disarmament
- P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1877 On the Value of Overseas Bases
- P-1887 Soviet Civil Defense
- P-1917 Psychological Inspection
- P-1927 Lecture on Civil Defense
- P-2340 Civil Defense Training in Russia
- P-2351 American Attitudes toward War: Their Influence on Arms Control Proposals
- P-2390 British Defense Policy: An American View
- P-2425 Soviet Views on the Role of Civil Defense
- P-2432 Hiders and Finders: An Approach to Inspection and Evasion Technology
- P-2554 The Soviet Civil Defense Program
- P-2562 Britain's Defense New Look Five Years Later
- T-123 West European Opinion on Defense—No. 41: German Polls of 1959 on Rearmament, Atomic Energy, Nuclear Weapons, the Balance of World Power, and Prospects of Peace

FRENCH STUDIES

- RM-1668-RC Paris from EDC to WEU
- RM-2170-RC Attitudes of the French Parliament and Government toward Atomic Weapons
- P-878-RC "*The Règle du Jeu of the French Parliament*": As Exemplified in the Election of President Coty
- P-1549 "*The Cultural and Social Impact of an American Airbase upon an Urban French Community*. By Orvoell R. Gallagher": A Summary

GERMAN STUDIES

- R-298 German Rearmament and Atomic War
- RM-515 German Press Reaction to the Air War in Korea
- RM-926 German Youth and Its Attitude toward a German Defense Contribution
- RM-927 The Attitude of the Christian Churches toward a German Defense Contribution
- RM-928 German Veterans' Organizations and the Defense Contribution
- RM-929 German Labor Unions and the Question of German Participation in European Defense
- RM-930 The Ideological Groups in Germany and Their Attitude toward the Defense Contribution
- RM-967 Bundestag Debates on Allied-German Relations: Allied-German Relations as Reflected in Selected Debates of the Bundestag, January to April, 1952
- RM-968 Early Discussion Regarding a Defense Contribution in Germany (1948–1950)
- RM-981 Public Discussion in Western Germany of the Defense of Europe, March to June, 1952
- RM-1056 Some Developments in German Aviation
- RM-1119 Soviet Policy on the Reunification of Germany, 1945–1952
- RM-1210 German Geopolitics Revived: A Survey of Geopolitical Writing in Germany Today
- RM-1372 Some German Press Views on the Defense of Europe: A Survey of West German Press Opinion on Military Aspects of the Defense of Europe
- RM-1506-RC The Politics of German Business
- RM-1668-RC Paris from EDC to WEU
- RM-1673-RC West German Trade Unions: Their Domestic and Foreign Policies

- P-458 German Rearmament and the Old Military Elite
- P-501 German Geopolitics Revived
- P-528-RC Political Views of the German Civil Service
- P-1106 A German Discussion of Atomic Weapons and the Law
- T-108 Political Control in the East German People's Army
- T-114 German Reports on East Bloc Activities: Central Planning for Atomic Protection in the East Bloc; and Ideological Training in the East German People's Army
- T-121 Summit Skirmishes in the Cold War
- T-122 "Military Disengagement in Central Europe": A Speech by Bundestag Delegate Helmut Schmidt (SPD)
- T-123 West European Opinion on Defense—No. 41: German Polls of 1959 on Rearmament, Atomic Energy, Nuclear Weapons, the Balance of World Power, and Prospects of Peace
- T-136 West German Attitudes toward Economic Aid for Underdeveloped Areas

INTERNATIONAL POLITICAL CONTEXT STUDIES

- RM-371 The Political Meaning of the Kostov Trial in Sofia, Bulgaria, December, 1949
- RM-1373 A Summary of *Recent Thought in Sweden on Western Defense* by James J. Robbins
- RM-1407 Recent Military Thought in Sweden on Western Defense
- RM-1837 Soviet Atomic Blackmail and the North Atlantic Alliance
- RM-1875 Odessa, 1941–1944: A Case Study of Soviet Territory under Foreign Rule
- RM-1948 Political Trends in the Hungarian Army, 1945–1956
- RM-2472 On Motives for "Disarmament" Research
- RM-2557 West European Comments on Soviet Posture as Presented in Khrushchev's Speech of January 14, 1960
- RM-2602 Social Patterns in the Hungarian Revolution
- RM-2914-PR The Labour Party and Unilateralism
- P-522 U.S. Reaction to North Korean Aggression
- P-524 Possible U.S. Military Strategies
- P-570 A Review of Sven Rydenfelt's *Communism in Sweden*
- P-697 Britain and the Defense of Western Europe
- P-825 United States Policies on Disarmament, 1946–1955: A Critique
- P-851 Political Behavior in a Crisis: Some Observations from the Berlin Blockade
- P-886 Policy Objectives and Military Action in the Korean War
- P-983 Deterrence Is Not Enough
- P-984 The Tragedy of Hungary: A Revolution Won and Lost
- P-1094 Soviet Atomic Blackmail and the North Atlantic Alliance
- P-1127 Intellectual Unrest behind the Iron Curtain
- P-1134 International Registration of the Atom
- P-1253 The Limits and Problems of "Decompression": The Case of Hungary
- P-1341 A Preface to U.S. Policy toward Russia
- P-1688 Outer Space and the International Scene
- P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1850 Is Deterrence Enough or Should We Be Prepared To Fight a General War in the 1960's?
- P-1888-RC The Nature and Feasibility of War and Deterrence
- P-1917 Psychological Inspection
- P-1938 The Peaceful Atom in Retrospect and Prospect
- P-1956 "Nth Countries" and Disarmament
- P-1965 Deterrence of Unlimited War: A Propositional Outline
- P-2000 The Violation of Arms Control Agreements: Deterrence versus Detection
- P-2025-2 Facts and Morals in the Arms Debate
- P-2059 The Korean War: Political Limitations
- P-2084-RC No Highway to High Purpose
- P-2330 Laos in Strategic Prospective
- P-2351 American Attitudes toward War: Their Influence on Arms Control Proposals
- P-2382-1 Communist China's Demands on the World
- P-2390 British Defense Policy: An American View
- P-2438 How Well Do We Know the Soviet Union?

SOCIAL AND POLITICAL SCIENCE—continued

INTERNATIONAL POLITICAL CONTEXT STUDIES—continued

- P-2482 Political Negotiation as a Process of Modifying Utilities
- P-2486 Air Transport and Economic Development: Some Comments on Foreign Aid Programs
- P-2508 Japan and Her Soviet Neighbor during the Interwar Years: Japanese Images and Reactions
- P-2509 Lord Russell, Unilateralism, and the Labour Party
- P-2562 Britain's Defense New Look Five Years Later
- T-32 The Brush-off Is Called "New Look"

MISCELLANEOUS

- R-106 New York Conference of Social Scientists
- R-353 On the Epistemology of the Inexact Sciences
- RM-1403-8 A Selected List of Unclassified Publications of the Social Science Department, The RAND Corporation, 1948-1961
- RM-2515 The Role of Theory in the Study of Conflict
- P-1513 On the Epistemology of the Inexact Sciences
- P-1538 Determinantal Methods in Latent Class Analysis
- P-1644 Partitioning Methods in Latent Class Analysis
- P-1648 Toward a Theory of Strategy for International Conflict
- P-2117 The "Contextual Study" Method as a Device for Studying Limited-war Strategies
- P-2461 By Automobile through Western Russia
- P-2542 Notes on a Conference with Soviet Scientists

PSYCHOLOGICAL AND POLITICAL WARFARE

- R-212 Air War and Emotional Stress: Psychological Studies of Bombing and Civilian Defense
- R-302 The Berlin Blockade: A Study in Cold War Politics
- RM-161 Are the Cominform Countries Using Hypnotic Techniques To Elicit Confessions in Public Trials?
- RM-365 The Exploitation of Superstitions for Purposes of Psychological Warfare
- RM-515 German Press Reaction to the Air War in Korea
- RM-974 International Communication and Political Warfare: An Annotated Bibliography
- RM-2595 The Chinese Genie: Peking's Role in the Nuclear Test Ban Negotiations
- P-196 Psychological Warfare Reconsidered
- P-226 Some Observations on the Role of Research in Political Warfare
- P-372 Military Demonstration and Disclosure of New Weapons
- P-604 The Impact of Air Power on the International Scene, 1933-1940
- P-615 Psychological Aspects of Foreign Policy
- P-616 The Scientific Status of Propaganda Analysis
- P-617 Qualitative and Quantitative Procedures in Content Analysis
- P-674 Some Thoughts on the Social Structure after a Bombing Disaster
- P-779 Prediction of Political Action by Means of Propaganda Analysis
- P-1224 The Human Side of the Berlin Airlift
- P-1801 A Scientist's Notes on the Cold War
- P-1869 Power: The Idea and Its Communication
- P-1956 "Nth Countries" and Disarmament
- P-2022 The Chinese Genie: Peking's Role in the Nuclear Test Ban Negotiations
- P-2117 The "Contextual Study" Method as a Device for Studying Limited-war Strategies

SOVIET IDEOLOGY

- R-206 The Operational Code of the Politburo
- R-239 A Study of Bolshevism
- RM-569 Some Useful Passages from Lenin and Stalin
- P-1283 Science and Doctrine in the Soviet Union
- P-2214 Laos: The Current Phase in a Cyclic Regional Revolution
- P-2493 The 22nd Congress of the CPSU: Some Domestic Implications

SOVIET MILITARY STUDIES

△ R-223 Soviet Military Doctrine

- R-326 War and the Soviet Union: Nuclear Weapons and the Revolution in Soviet Military and Political Thinking
- RM-207a Soviet Military Intelligence: Comments on the Book *Handbook for Spies* by Alex Foote
- RM-788 Political Vulnerability of Moscow: A Case Study of the October, 1941, Attack
- RM-1637 *Red Star* on Military Affairs, 1945-1952: A Selected, Annotated List of Articles in the Soviet Military Newspaper
- RM-1638 The Role of the Military in Recent Soviet Politics
- RM-1760 A Casebook on Soviet Astronautics
- RM-1896 The Soviet Union and the Atom: The "Secret" Phase
- RM-1922 A Casebook on Soviet Astronautics—Part II
- RM-2102 The Soviet Military Posture as a Reflection of Soviet Strategy
- RM-2163 The Soviet Union and the Atom: Toward Nuclear Maturity
- RM-2532 Soviet Strategic Ideas, January 1960
- RM-2534 The Significance of Chinese Communist Treatment of Khrushchev's January 14 Speech on Strategy
- RM-2557 West European Comments on Soviet Posture as Presented in Khrushchev's Speech of January 14, 1960
- RM-2618 "Deterrence" and Surprise Attack in Soviet Strategic Thought
- RM-2771 Military Force and Soviet Goals
- RM-3053-PR Recent Soviet Advances in Aerospace Technology
- P-521 Significant Features of Soviet Military Doctrine
- P-603 Soviet Attitudes toward Modern Air Power
- P-684 The Soviet High Command and General Staff
- P-726 Recent Trends in Soviet Military Policy
- P-937 The Role of the Military in Post-Stalin Soviet Politics
- P-1076 The Soviet Atomic Power Program: Large or Small?
- P-1351 The Political Position of the Soviet Army since Stalin
- P-1388 The Soviet Ballistic Missile and Space Flight Program
- P-1391 Nuclear Energy in the USSR
- P-1711 The Organization of Atomic Energy in the USSR
- P-1887 Soviet Civil Defense
- P-1925 Soviet Strategic Ideas, January 1960
- P-2005 Soviet Atomic Energy
- P-2009 Time and Civil Defense
- P-2016 "Deterrence" and Surprise Attack in Soviet Strategic Thought
- P-2107 Appraising Soviet Astronautics
- P-2340 Civil Defense Training in Russia
- P-2415 Soviet Civil Defense
- P-2425 Soviet Views on the Role of Civil Defense
- T-29 When Can the Soviet Union Risk Atomic War?
- T-33 The Secret Weapons of the Soviet Union
- T-36 Chats on the Atomic Weapon
- T-40 Soviet Long-range Bomber Bases near the North Pole
- T-43 Two German News Items on Atomic Developments in the Soviet Union
- T-72 Excerpt from "Construction of Aircraft" (*Konstruktsii Samoletov*) Dealing with the Evolution and Uses of Soviet Airplanes
- T-73 Some New Soviet Material on Missiles
- T-77 Two Russian Articles on the Ballistic Missile
- T-82 Soviet Commentary on the Doctrine of Limited Nuclear Wars
- T-83 Anti-atomic Defense in the Soviet Air Force
- T-84 Some Soviet Views on Air Strategy
- T-87 On the Question of the Pre-emptive Blow by General of the Army V. Kurasov
- T-97 Some Soviet Views on the Nature of a Future War and the Factors Determining Its Course and Outcome
- T-116 "The Airfield Continues to Operate"

SOCIAL AND POLITICAL SCIENCE—continued

SOVIET POLICY STUDIES

- R-201 The Organizational Weapon: A Study of Bolshevik Strategy and Tactics
- RM-1003 The Stalinist Heritage in Soviet Foreign Policy
- RM-1819 Soviet Collective Leadership
- RM-1874 The Politics of Soviet De-Stalinization
- RM-1881 The Psychological Factor in Soviet Foreign Policy
- RM-1949 The Changing Pattern of Soviet Foreign Policy
- RM-2075 Soviet Administrative Controls during the Siege of Leningrad
- RM-2163 The Soviet Union and the Atom: Toward Nuclear Maturity
- RM-2290 The Soviet Union and the Atom: Peaceful Sharing, 1954–1958
- RM-2438 Khrushchev's Major Informal Interviews with Non-bloc Leaders, January 1, 1957–August 1, 1959: A Selected Bibliography and Chronology
- RM-2557 West European Comments on Soviet Posture as Presented in Khrushchev's Speech of January 14, 1960
- RM-2657 The Chinese Communist Line on Neutralism
- RM-2771 Military Force and Soviet Goals
- P-1052 The Psychological Factor in Soviet Foreign Policy
- P-1058 The Politics of Soviet De-Stalinization
- P-1283 Science and Doctrine in the Soviet Union
- P-1391 Nuclear Energy in the USSR
- P-1447 Dynamics of the Moscow-Peking Axis
- P-1469 Military Thought and Politics in the USSR
- P-1711 The Organization of Atomic Energy in the USSR
- P-1714 The Sino-Soviet Alliance: How Durable?
- P-1741 Peaceful Atomic-energy Programs in Soviet Bloc Nations
- P-1801 A Scientist's Notes on the Cold War
- P-1953 Sinkiang and Sino-Soviet Relations
- P-1987 Why Are the Chinese Nervous?
- P-2005 Soviet Atomic Energy
- P-2026 The Chinese Communist Line on Neutralism
- P-2029 Conflict Resolution in the Sino-Soviet Alliance
- P-2098 Moscow, Peking, and Japan: Views and Approaches
- P-2254 Current Communist Tactics in Indonesia
- P-2397 The Sino-Soviet Conflict over the Transition to Communism
- P-2415 Soviet Civil Defense
- P-2438 How Well Do We Know the Soviet Union?
- P-2478-1 Khrushchev's Attack on Albania and Sino-Soviet Relations
- P-2493 The 22nd Congress of the CPSU: Some Domestic Implications
- P-2542 Notes on a Conference with Soviet Scientists
- P-2554 The Soviet Civil Defense Program
- P-2561 Some Comparisons between the Russian and Chinese "Models"
- T-121 Summit Skirmishes in the Cold War

SOVIET POLITICAL CONTEXT STUDIES

- R-199 Soviet Attitudes toward Authority
- RM-923 Leadership in Soviet Agriculture and the Communist Party
- RM-977 Ritual of Liquidation: The Case of the Moscow Trials
- RM-1004 The Statutes of the Communist Party: Democratic Façade and Totalitarian Reality
- RM-1086 The New Soviet Leadership
- RM-1223 The Metamorphosis of the Stalin Myth
- RM-1441 Stalin and the Uses of Psychology
- RM-1636 Forces for Change in Soviet Society
- RM-1674 Collective Leadership and the Political Police in the Soviet Union
- RM-1711 The Soviet Union and the Atom: The Early Years
- RM-1756 Recent Trends in Soviet Labor Policy

- RM-1883 Khrushchev and the Stalin Succession: A Study of Political Communication in the USSR
- RM-1947 Khrushchev and the Political Crisis of June, 1957
- RM-2163 The Soviet Union and the Atom: Toward Nuclear Maturity
- RM-2438 Khrushchev's Major Informal Interviews with Non-bloc Leaders, January 1, 1957–August 1, 1959: A Selected Bibliography and Chronology
- RM-2494 The Control of Industrial Labor in the Soviet Union
- RM-2763 The Khrushchev Succession Problem
- RM-3053-PR Recent Soviet Advances in Aerospace Technology
 - P-171 Politburo Images of Stalin
 - P-242 The Politburo through Western Eyes
 - P-367 Totalitarianism and the Future
 - P-370 The Soviet Purge: 1953 Version
- P-401 The New Soviet Leadership
 - P-408 Stalin as an Intellectual
- P-418 The Soviet Image of the U.S.
 - P-421 Purges in the Soviet Union and in the Satellites
 - P-507 The Metamorphosis of the Stalin Myth
 - P-768 Politics of the Russian Emigration
 - P-788 The Soviet Approach to International Political Communication
 - P-815 Stalin and the Uses of Psychology
 - P-843-RC Censorship in the USSR: A Documented Record
- P-853 Soviet Atomic Policy
- P-865 Documents on the Russian Emigration: An Appendix to RAND Paper P-768
- P-945 The Russian Future: Is a New Optimism Justified?
- P-1048 Soviet Labor and the Question of Productivity
- P-1135 Khrushchev and the Political Crisis of June, 1957
- P-1142 Forces for Change in Soviet Society
- P-1146 Khrushchev as Senior Secretary: His Rise and His Ambitions
- P-1265 The Image of Dual Russia
 - P-1312 The Bureaucratic Elite in Soviet Politics
 - P-1317 The Soviet Employment of Military Strength for Political Purposes
- P-1336 The Russian Urban Worker: From Serf to Proletarian
- P-1373 Talmudism in Soviet Politics
- P-1570 Impressions of Russia in 1958: A Trip Report
 - P-1641 The Communist World of Mr. Lippman
 - P-1711 The Organization of Atomic Energy in the USSR
 - P-1741 Peaceful Atomic-energy Programs in Soviet Bloc Nations
- P-1754 The USSR in the Technological Race
 - P-1859 Report on Service with the American Exhibition in Moscow
 - P-2107 Appraising Soviet Astronautics
 - P-2229 General Nasution's Mission to Moscow
 - P-2283 The Khrushchev Succession Problem
 - P-2386-1 The Succession Problem and the Transition to Communism
 - P-2478-1 Khrushchev's Attack on Albania and Sino-Soviet Relations
 - P-2480 The Soviet Union and the Political Uses of Outer Space
 - P-2542 Notes on a Conference with Soviet Scientists
 - P-2561 Some Comparisons between the Russian and Chinese "Models"
- T-37. On the New American Submarine *Nautilus*
- T-50 Soviet Schools in Science: Translation of and Comments on a Russian Literary Gazette Article
 - T-62 Results of Experiments in Organizing the Stepwise Scheduled Routes on the RR Line Korosten-Odessa: By Dul'N'yev, Furman, Baranov, and Sin'Yov
 - T-91 *Russia's New Middle Class*, by Alf Edeen
 - T-103 East Bloc Forgeries: A Weapon in the Cold War
 - T-107 Soviet Book Review of A. S. Whiting's *Soviet Policies in China, 1917–1924*
 - T-110 World-wide Historic Victory of the Soviet People
 - T-112 "Why the USA Is Straining To Get into Outer Space"

SPACE FLIGHT—See also Aerodynamics and Fluid Mechanics, Applied Mechanics, Guidance and Control, Human Engineering, Meteorology, Navigation, Physics, and Propulsion

INTERPLANETARY FLIGHT

- R-389-PR Distribution of the Intensity and Polarization of the Diffusely Reflected Light over a Planetary Disk
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RM-2671 A Method for Determining Approximate Propulsion Cutoff Conditions for Ballistic Interplanetary Trajectories
- RM-2825-PR Solar-flare Radiation and Manned Space Flight
- RM-2881-PR Some Methods for Establishing Interplanetary Transfer Orbits
- P-978 The Atmosphere of Venus
- P-1406 Experiments in Interplanetary Biomigration and Space Contamination
- P-1432 Interplanetary Exploration
 - P-1535 On Lunar and Planetary Experiments
- P-1559 The Status and Improvement of Physical Constants Needed for Precision Trajectories
 - P-1593 The Problem of the Martian Blue Haze
 - P-1669 Space Flight for Man
 - P-1693 Main Street and Mars
 - P-1757 Probing Space: The Astronomer's View
- P-2068 Observations of the Blue Haze in the Atmosphere of Mars
 - P-2157 Determination of Interplanetary Transfer Orbits for Specified Date of Departure
- P-2285 A Method for Determining Approximate Initial Conditions for Interplanetary Trajectories
 - P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute
 - P-2387 On the Consequences of a Possible Ozonosphere on Mars
- T-38 Problems of Interplanetary Flights
 - T-85-PR The Determination of Orbits

LUNAR FLIGHT

- RM-1725 Lunar Instrument Carrier: Landing Factors
- RM-1726 Motion of a Small Body in Earth-Moon Space
- RM-1728 Lunar Instrument Carrier: Trajectory Studies
- RM-1730 Lunar Instrument Carrier: Attitude Stabilization
- RM-1764 Observations of the Moon from the Moon's Surface
- RM-1900 Visual Detection of Light Sources On or Near the Moon
- RM-1933 Utilization of a Moon-rocket System for Measurement of the Lunar Magnetic Field
- RM-1941 Artificial Satellites of the Moon
- RM-2106 Evolution and Nature of the Lunar Atmosphere
 - RM-2183 A Photographic System for Close-up Lunar Exploration
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
 - P-833 The Moon Rocket
 - P-873 Artificial Satellites of the Moon
 - P-1021 Tracking and Communication for a Moon Rocket
- P-1022 Accuracy Requirements for Trajectories in the Earth-Moon System
- P-1119 Recovery of a Circum-lunar Instrument Carrier
 - P-1248 Lunar Flight
- P-1268 Lunar Flight Trajectories
 - P-1293 Lunar Trajectory Studies
- P-1304 Certain Ecological Aspects of a Closed Lunar Base
- P-1344 Physics of Solar-Terrestrial Space: Lunar Flight
 - P-1409 Lunar Rays: Their Formation and Age
- P-1436 Lunar-base Planning Considerations
- P-1441 Circumlunar Trajectory Studies
 - P-1453 Lunar Flight Dynamics
 - P-1535 On Lunar and Planetary Experiments
- P-1559 The Status and Improvement of Physical Constants Needed for Precision Trajectories

- P-1636 Some Weight Considerations for Manned Lunar Missions
- P-1671 Lunar Exploration by Photography from a Space Vehicle
- P-1757 Probing Space: The Astronomer's View
- P-1892 How Good Is the Lunik III Moon Photography?
- P-1969 Analysis of Possible Lunik III Picture Hoax
- P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute

MISCELLANEOUS

- R-311 Behind the Sputniks: A Survey of Soviet Space Science
- R-362-RC International Political Implications of Activities in Outer Space: A Report of a Conference, October 22-23, 1959
- RM-1760 A Casebook on Soviet Astronautics
- RM-1922 A Casebook on Soviet Astronautics—Part II
- RM-2113-1 An Annotated Bibliography of RAND Space Flight Publications
- RM-2161 Outline of a Study of Extraterrestrial Base Design
- RM-2174 Lunar Base Study Jury Report: Evaluation of an Experiment in Creative Design Conducted with College Students
- RM-2273 A Problem in Spectrum Estimation
- RM-2332 Estimated Damage to Space Vehicles by Meteoroids
- RM-2400 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—I: Hydrogen
- RM-2401 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—II: Ammonia
- RM-2402 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—III: Water
- RM-2403 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—IV: Lithium Hydride
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RM-2542 The Sabatier Reaction for Inorganic Recovery of Oxygen in Manned Space Capsules
- RM-2567 Summary of Orbital and Physical Data for the Planet Mars
- RM-2579 Atmospheric Entry of Manned Vehicles
- RM-2668 Design Criteria for Rotating Space Vehicles
- RM-2825-PR Solar-flare Radiation and Manned Space Flight
- RM-2879-PR The Gravitational Concentration of Particulate Matter in the Space near the Earth
- RM-3053-PR Recent Soviet Advances in Aerospace Technology
- P-1303 Trajectory Fundamentals
- P-1322 The Penetration of Planetary Atmospheres
- P-1335 Space-vehicle Environment
- P-1388 The Soviet Ballistic Missile and Space Flight Program
- P-1435 Some Political Implications of the Space Age
- P-1437 Soviet Astronautics
- P-1442 Some Aspects of Astronautics
- P-1446 Multiple Image Printing for Planetary Photography
- P-1499 The Space Environment
- P-1524 Direct-power Conversion—Part I: General Comments
- P-1558 A Layman's Review of Propulsion and Propellants for Space Flight
- P-1562 Soviet Periodical Literature on Astronautics
- P-1577 Environmental Requirements for Extended Occupancy of Manned Satellites
- P-1589 Economic Considerations of Space Flight Ground Support Requirements
- P-1626 Some Preliminary Scientific Findings of the International Geophysical Year
- P-1633 The Impact of the Space Age on Engineering Education
- P-1637 The Design of Large-area Astronautical Objects
- P-1680 Triangle: Man, Machine, Space
- P-1688 Outer Space and the International Scene
- P-1702 Space Investigation in the USSR: Past, Present, and Future
- P-1712 Meteors: Frequency, Size, and Depth of Penetration
- P-1788 Estimation of Doppler Shifts in Noise Spectra

SPACE FLIGHT—continued

MISCELLANEOUS—continued

- P-1860 Maximum Total Energy of the Van Allen Radiation Belt
- P-1863 The Survey of the Geomagnetic Field in Space
- P-1878 Main Street, the Moon, and What Next?
- P-1890 Atmospheric Entry of Manned Vehicles
- P-1915 Celestial Frontiers
- P-1936 Comments on "The Effect of Micrometeorites on Reflecting Surfaces"
- P-1963 Meteoroids versus Space Vehicles
- P-1975 Economic Aspects of Developing and Orbiting a Space Station
- P-2003 Temperature and Circulation of the Venus Atmosphere
- P-2038 Low-acceleration Transfer Orbits
- P-2043 The Computational Solution of Variational Problems
- P-2051 Manpower Planning for the Space Age
- P-2052 Atmospheric Entry
- P-2099 Utilization of Space from a National Standpoint
- P-2107 Appraising Soviet Astronautics
- P-2108 Space Exploration: A National Challenge
- P-2172 Meteoroid Hazard to Nuclear Power Stations in Space
- P-2218-1 Thermodynamic Properties of Carbon Dioxide to 24,000°K
- P-2261 Soviet Space Experiments and Astronautics
- P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute
- P-2383 Anyone for the Moon?
- P-2399 Detection of Nuclear Explosions
- P-2434 The Problem of Detecting Nuclear Explosions
- P-2456 The Thermodynamic Properties of 85% CO₂ and 15% Nitrogen to 24000°K
- P-2480 The Soviet Union and the Political Uses of Outer Space
- P-2538 A Game Theoretic Approach to Space Vehicle Prelaunch Activities Scheduling
- T-69 The Attainability of the Stars (*Die Erreichbarkeit der Fixsterne*)
- T-111 The Role of True Absorption in the Atmosphere of Mars
- T-112 "Why the USA Is Straining To Get into Outer Space"
- T-115 The Stellar Ecospheres with a Radius of 17 Light-years around the Sun

ORBITS AND TRACKING

- RM-2172 A Possible Transponding System for an Artificial Asteroid
- RM-2581 A Discussion of a Midcourse Guidance Technique for Space Vehicles
- RM-2643 Oblateness Perturbations of Near-earth Satellites
- RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
- RM-2881-PR Some Methods for Establishing Interplanetary Transfer Orbits
- P-1256 Aerodynamics for Space Flight
- P-1335 Space-vehicle Environment
- P-1481 The Propagation of Errors in Keplerian Orbits
- P-1496 Atmospheric Perturbations of Artificial Satellites
- P-1518 Problems of Range Measurement with Special Application to the Establishment of an Orbit of an Artificial Asteroid
- P-1536 Low-thrust Transfer between Circuit Orbits
- P-1568 A Discussion of Space Vehicle Guidance Problems
- P-1611 Secular Variation in the Inclination of the Orbit of Earth Satellite (1957 β) and Air Drag
- P-1737 Tables of True Anomaly versus Time Interval for Keplerian Orbits
- P-1738 Fundamentals of Satellite Acquisition Ephemerides
- P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
- P-1968 A Computer Program for First-order-error Propagation in Satellite-orbit Prediction
- P-1992 Limits for Stable Near-circular Planetary or Satellite Orbits in the Restricted Three-body Problem
- P-2157 Determination of Interplanetary Transfer Orbits for Specified Date of Departure

- P-2177-1 The Optimization of Multi-stage Orbit Transfer Processes by Dynamic Programming
- P-2343-1 Equations of Perturbed Motion for Low-eccentricity Orbits
- P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute
- P-2402 A Computational Procedure for Optimal Control Problems with State Variable Constraint
- T-85-PR The Determination of Orbits

SATELLITES

- SM-11827 Preliminary Design of an Experimental World-circling Space Ship
- RA-15006 Status of Satellite Study
- RA-15021 Flight Mechanics of a Satellite Rocket
- RA-15022 Aerodynamics, Gas Dynamics, and Heat Transfer Problems of a Satellite Rocket
- RA-15027 Satellite Rocket Powerplant
- RA-15028 Communication and Observation Problems of a Satellite
- RA-15029 Study of Launching Sites for a Satellite Projectile
- RA-15031 Proposed Type Specification for an Experimental Satellite
- RA-15032 Reference Papers Relating to a Satellite Study
- R-311 Behind the Sputniks: A Survey of Soviet Space Science
- R-339 Aerodynamics of the Upper Atmosphere
- RM-1194 Scientific Uses for a Satellite Vehicle
- RM-1459 Scientific Satellite-payload Considerations
- RM-1500 Scientific Use of an Artificial Satellite
- RM-1693 Skin Temperature Variation during Re-entry of Scientific Satellite
- RM-1844 A Recoverable Scientific Satellite
- RM-2225 Two Methods of Obtaining Earth Satellite Positions from Simple Photographic Observations
- RM-2264 Preliminary Analysis of a Satellite Recovery System
- RM-2276 Minimal Impulse Requirements for Disorbiting Satellites
- RM-2286 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- RM-2313 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow with Application to Neutral-particle Drag Estimates of Satellites
- RM-2329 First-order Error Propagation in a Stagewise Smoothing Procedure for Satellite Observations
- RM-2527 General Equations of Motion of a Satellite in a Gravitational Gradient Field
- RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
- RM-3096-PR Idealized Sheath Theory and Satellite Charge-up in the Van Allen Region
- P-733 Scientific Use of an Artificial Satellite
- P-760 Use of an Artificial Satellite in Upper Air Research
- P-958 A Recoverable Scientific Satellite
- P-1263 Studies of Ionospheric Radiophysics by Means of Satellites
- P-1292 A Proposed Stagewise Differential Correction Procedure for Satellite Tracking and Prediction
- P-1402 Satellite Weather Reconnaissance
- P-1460 Earth-period (24-hour) Satellites
- P-1463 An Application of Dynamic Programming to the Determination of Optimal Satellite Trajectories
- P-1496 Atmospheric Perturbations of Artificial Satellites
- P-1501 I.G.Y. Rockets and Satellites: A Report on the Moscow Meetings, August 1958
- P-1511 Power for Satellites
- P-1520 On the Drag of a Sphere Moving in a Partially Ionized Atmosphere
- P-1536 Low-thrust Transfer between Circular Orbits
- P-1542 Suitability of Solid and Liquid Rocket Engines for Placing Manned Satellites on Orbit
- P-1561 Satellite Perturbations Resulting from Lunar and Solar Gravitational Effects
- P-1591 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- P-1609 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow, with Application to Satellite Drag
- P-1611 Secular Variation in the Inclination of the Orbit of Earth Satellite (1957 β) and Air Drag

SPACE FLIGHT—continued

SATELLITES—continued

- P-1619 An Introduction to Do-it-yourself Satellites
- P-1674 First-order Error Propagation in a Stagewise Smoothing Procedure for Satellite Observations
- P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1735 Spectral Measurements of Atmospheric Radiation from a Meteorological Satellite
- P-1738 Fundamentals of Satellite Acquisition Ephemerides
- P-1864 Ascent Guidance for a Satellite Rendezvous
- P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
- P-2002 Effect of Geometrical Libration on the Damped Motion of an Earth Satellite
- P-2030 On Style in Research and Development
- P-2158 The Analysis and Solution of Optimum Trajectory Problems
- P-2216 The Economic Potential of Communication Satellites
- P-2314 Aspects of Synchronous Communication Satellites
- P-2343-1 Equations of Perturbed Motion for Low-eccentricity Orbits
- P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute
- P-2395 Broadcasting from Satellites
- P-2396 Economic Aspects of Communication Satellite Systems
- P-2441 Satellite Charge-up in the Outer Van Allen Belt
- T-52 The Motion of a Satellite Station around the Earth in an Elliptical Orbit Inclined to the Earth's Equator
- T-89 Some Results Taken from Observations of the First Russian Earth Satellites

SPACE LAW

- R-362-RC International Political Implications of Activities in Outer Space: A Report of a Conference, October 22–23, 1959
- P-1087 Space Law Bibliography
- P-1088 Legal Terminology for the Upper Regions of the Atmosphere and for the Space beyond the Atmosphere
- P-1290 A Guide to the Study of Space Law, Including a Selective Bibliography on the Legal and Political Aspects of Space
- P-1324 Japanese Views on Extraterrestrial Law and Order
- P-1434 Outer Space and International Law
- T-78 The Artificial Satellite and International Law
- T-98 Translations of Two Soviet Articles on Law and Order in Outer Space
- T-141 On Problems Concerning the Legal Status of Outer Space

SPACE OPERATIONS

- R-362-RC International Political Implications of Activities in Outer Space: A Report of a Conference, October 22–23, 1959
- RM-1641 Graphical Determination of Ballistic Trajectories: Through Outer Space with Compass and Straightedge
- RM-2161 Outline of a Study of Extraterrestrial Base Design
- RM-2174 Lunar Base Study Jury Report: Evaluation of an Experiment in Creative Design Conducted with College Students
- RM-2314 Damage to X-ray Detectors by Meteorites
- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
- RM-2539 Vehicles for Exploration on Mars
- RM-2887-PR Minimum-weight Design for Moving Loads
- RAOP-18 Probability That a Meteorite Will Hit or Penetrate a Body Situated in the Vicinity of the Earth
- P-1244 Electric Power for Space Flight
- P-1259 Basic Objectives of a Continuing Program of Scientific Research in Outer Space
- P-1305 Propagation Considerations in Space Operations
- P-1309 Internal Environment of Manned Space Vehicles
- P-1318 A Discussion of Energy Sources for Space-communications

- P-1350 Scientific Exploration in the Fringe of Space
- P-1387 Space Flight Trajectories, Navigation, and Maneuvers
- P-1389 Power in Space
- P-1393 Some Information-theory Considerations in Space Communications
- P-1394 Communications in Space Operations
- P-1420 Materials for Space Flight
- P-1425 Prologue to a Syntax of Space Exploration
- P-1427 The Space Environment
- P-1428 Types of Space Flights
- P-1430 Orientation and Control
- P-1431 Space-flight Ground-facility-requirements Problems: Launching Facilities
- P-1436 Lunar-base Planning Considerations
- P-1438 Food Preservation
- P-1443 Space Communications
- P-1553 Cosmic Terrestrial Relations
- P-1557 The Symposium on the Use of Space Vehicles at the Fall, 1958, URSI Meeting
- P-1558 A Layman's Review of Propulsion and Propellants for Space Flight
- P-1577 Environmental Requirements for Extended Occupancy of Manned Satellites
- P-1662 Effects of a Meteoroid Impact on Steel and Aluminum in Space
- P-1757 Probing Space: The Astronomer's View
- P-1834 Manned Control of Orbital Rendezvous
- P-1841 Vehicles for Exploration on Mars
- P-1861 Space Vehicle Power Plants
- P-1874 Design and Operation of Ground Guidance Systems
- P-1878 Main Street, the Moon, and What Next?
- P-1891 Powerplants for Atmospheric and Surface Vehicles on Mars
- P-1908 Propulsion Requirements for Rendezvous in Orbit
- P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
- P-2106 Semi-coherent Detection
- P-2261 Soviet Space Experiments and Astronautics
- P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute

STATISTICS—See also Game Theory and Mathematics

DISTRIBUTION THEORY

- RM-40 A "Semi-Poisson" Distribution
- RM-87 Examination of Some Models of Failure of Equipment during Operation
- RM-97 Hermite Polynomials of Imaginary Argument
- RM-111 An Asymptotic Distribution for a Mortality Problem
- RM-145 Target Coverage
- RM-163 Area Coverage with Ordinary Bombs
- RM-191 Expected Coverage When All Bombs Are Aimed at the Center of the Target
- RM-447 On the Roots of Markoffian Random Functions
- RM-686 A Stochastic Development of "Ballantyne's Integral Equation"
- RM-721 Short Proof of a Theorem of Gross
- RM-894 A Characterization of the Normal Distribution
- RM-1094 Distributions of Surviving Bombers in Certain Air Battle Models
- RM-1357 Confidence Intervals for Poisson Parameters in Logistics Research
- RM-1820 The Goodness-of-fit Statistics of Kolmogorov and Smirnov
- RM-1905 The Moments of Two Limiting Distributions of Kolmogorov
- RM-1958 The Moments of Two Distribution-free Statistics of Smirnov
- P-94 Integral of the Gaussian Distribution over an Offset Ellipse
- P-139 On a Theorem of Doob
- P-169 Some Statistical Problems Connected with Stochastic Processes
- P-207 First Passage and Recurrence Distributions
- P-414 A Simple Derivation of the Poisson Distribution
- P-419 Passage of Stationary Processes through Linear and Nonlinear Devices
- P-910 A Min-Max Solution of an Inventory Problem

STATISTICS—continued

DISTRIBUTION THEORY—continued

- P-1077 The Small Sample Distribution of $n\omega_n^2$
- P-1192 A New Approach to the Kolmogorov-Smirnov Distributions
- P-1475 The Moments of Two Limiting Distributions of Kolmogorov
- P-1476 The Moments of Two Distribution-free Statistics of Smirnov
- P-1806-1 Parameter-free and Nonparametric Tolerance Limits: The Exponential Case
- P-1807 Tables of the Binomial Probability Distribution $b(r; N, p)$ for Large N and Small p
- P-1852 Multiple Regression Analysis of a Poisson Process
- P-1983 Model of Error Burst Structure in Data Transmission
- P-2144 On the Generation of Normal Random Vectors
- P-2207 Asymptotic Behavior of the Total Cost Function for Dynamic Inventory Processes
- P-2325 Tests of Homogeneity for Correlated Samples
- P-2421 Various Properties of the Poisson Distribution
- P-2536 On the Output Probability Density Function of a Linear Device with Certain Non-gaussian Random Inputs
- T-27 A Summary of Known Distribution Functions
- T-45 On a Problem of the Comparison of Two Empirical Distributions
- T-66 Asymptotic Expansions for the Distribution of Maximum Deviations in the Bernoulli Scheme
- T-71 On Some Identically Distributed Statistics
- T-92 Theory and Applications of the Notion of Complex Signal

ESTIMATION PROCEDURES

- RM-10 An Experiment in Estimation
- RM-92 Forecast of Production Time
- RM-111 An Asymptotic Distribution for a Mortality Problem
- RM-133 Expected Overlap
- RM-135 Estimation of Mortality Parameters
- RM-148 Some Comments on an Estimation Problem for Contaminated Populations
- RM-177 On the Usefulness of Artificial Dispersion for a Certain Bombing Problem
- RM-302 A Model for the Reliability of Complex Mechanisms
- RM-306 Expected Coverage with Conventional Bombs When Rectangular Patterns Are Employed against Rectangular Targets
- RM-323 On the Expected Damage from Single Bomb Drops
- RM-370 Estimation in Truncated Sampling Processes
- RM-563 Estimating Output from Floor Space: Feasibility
- RM-727 Use of Experts for Estimation of Bombing Requirements: Project Delphi Experiment
- RM-1220 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements
- RM-1321 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements: Minimum RMS Error in Computed Position
- RM-1632 Expected Damage from Single and Multiple Bombs to Targets Distributed Uniformly around a Circle
- RM-1807 A Method for Estimating Engine Failure Rates
- RM-2552 Approximate Confidence Limits for the Reliability of Series and Parallel Systems
- RM-3090-PR Interpolation and Extrapolation of Stationary Random Sequences
- P-93 The Prediction of Social and Technological Events
- P-337 Methods of Reducing Sample Size in Monte Carlo Computations
- P-556 Univariate Two-population Distribution-free Discrimination
- P-725 A Note on Randomized Branch Sampling
- P-756 An Introductory Note for the Proceedings of the Gainesville, Florida, Symposium on Monte Carlo Methods
- P-766 Use of Different Monte Carlo Sampling Techniques
- P-1185 A Method of Computing the Inherent Accuracy with Which a Time Delay Can Be Estimated
- P-1236 The Fitting of Straight Lines When Both Variables Are Subject to Error

- P-1289 A Note on "Efficient Estimation and Local Identification in Latent Class Analysis"
- P-1348 Some Finite Population Unbiased Ratio and Regression Estimators
- P-1355 On the Maximum Likelihood Estimate of the Correlation Coefficient
- P-1358 Least Squares Estimation in Finite Markov Processes
- P-2092 Statistical Methods in Markov Chains
- P-2138 Problems of Force Posture Evaluation
- P-2362 On the Determination of Occupational Categories in an Organization
- P-2401 Approximate Confidence Limits for the Reliability of Series and Parallel Systems
- P-2502 Some Statistical Properties of Selected Inventory Models
- P-2517 A Brief Review of Inventory Theory

MISCELLANEOUS

- RM-1317 Notes on the Analysis of "Immersed" Variance
- RM-2423 Use of Tolerance Limits in Missile Reliability Analysis
- RAOP-17 Sampling Inspection Plans for Continuous Production
- P-96 The Future of Mathematical Statistics and Quality Control
- P-180 Some Nonparametric Results for Experimental Designs
- P-646 The Application of Statistical Methods to the Design and Analysis of Experiments
- P-710 Some Observations on Factor Analysis
- P-1160 Statistical Decision Theory as a Guide to Information Processing
- P-1376 A Method for Determining Supply Quantity for the Case of Poisson Distribution of Demand
- P-1396 Some Statistical Methods of Potential Value in Radio Wave Propagation Investigations
- P-1418 Bounds on the Expectation of a Convex Function of a Multivariate Random Variable
- P-1423 Use of Tolerance Limits in Missile Evaluation
- P-1473 The Distribution of Radial Error and Its Statistical Application in War Gaming
- P-1528 Statistical Methods in Radio-wave Propagation
- P-1538 Determinantal Methods in Latent Class Analysis
- P-1644 Partitioning Methods in Latent Class Analysis
- P-1806-1 Parameter-free and Nonparametric Tolerance Limits: The Exponential Case
- P-1993 A Heuristic Program for Assembly-line Balancing
- P-2224 Correlation of Rock Properties by Statistical Methods
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2407 Probability and Statistics in Systems Work

RANDOM SAMPLING

- RM-5 Randomness
- RM-38 Tests of the Randomness of Digits
- RM-74 A Differential Equation with Random Shocks
- RM-181 An Upper Limit to Cycle-length in a Sequence of Digit Groups
- RM-234 A Note on the Monte Carlo Method and the Potential Equation
- RM-284 Some Statistical Problems Connected with Stochastic Processes
- RM-447 On the Roots of Markoffian Random Functions
- RM-1237-AEC Applications of Monte Carlo
- RM-2149 Monte Carlo Models for Estimating Reliability: An Exploratory Analysis
- RAOP-10 Concerning Compound Randomization in the Binary System
- RAOP-44 Some Tests of the Randomness of a Million Digits
- P-88 Stochastic (Monte Carlo) Attenuation Analysis
- P-113 History of RAND's Random Digits: Summary
- P-337 Methods of Reducing Sample Size in Monte Carlo Computations
- P-531 The Use of Multistage Sampling Schemes in Monte Carlo Computations
- P-725 A Note on Randomized Branch Sampling
- P-756 An Introductory Note for the Proceedings of the Gainesville, Florida, Symposium on Monte Carlo Methods
- P-766 Use of Different Monte Carlo Sampling Techniques
- P-1174 Experimentation by Simulation and Monte Carlo
- P-1232 A Note on Preventative Sampling
- P-1521 Reliability Estimating by the Use of Random Sampling Simulation

STATISTICS—continued

RANDOM SAMPLING—continued

- P-1638 The Application of Random Sampling Simulation to Reliability Estimating
- P-2144 On the Generation of Normal Random Vectors

SIGNIFICANCE TESTS

- RM-271 A Note on the Power Function of the Wald-Wolfowitz Tolerance Limits for a Normal Distribution
- RAOP-7 On the Power Function of a Sign Test Formed by Using Subsamples
- RAOP-8 On the "Information" Lost by Using a t -Test When the Population Variance Is Known
- RAOP-13 Some Bounded Significance Level Properties of the Equal-tail Sign Test
- RAOP-32 On the Best Choice of Sample Sizes for a t -Test When the Ratio of Variances Is Known
- RAOP-42 Some Bounded Significance Level Tests of Whether the Largest Observations of a Set Are Too Small
- P-61 Some Nonparametric Tests of Whether the Largest Observations of a Set Are Too Large or Too Small
- P-65 Some Estimates and Tests Based on r Smallest Values in a Sample
- P-80 On the Power Function of the "Best" t -Test Solution of the Behrens-Fisher Problem
- P-86 Large Sample Tests and Confidence Intervals for Mortality Rates
- P-91 On the Power Function of Tests of Percentage Points Based on the Noncentral t -Statistics
- P-92 Some Comments on the Efficiency of Significance Tests
- P-102 On a Generalization of the Behrens-Fisher Problem
- P-112 Concerning the Effect of Small Correlation on Certain Large Sample Tests and Confidence Intervals for the Mean
- P-129 A Large Sample t -Statistic Which Is Insensitive to Nonrandomness
- P-133 Some Tests for Comparing Percentage Points of Two Arbitrary Continuous Populations
- P-156 Some Bounded Significance Level Tests for the Median
- P-179 A Large Sample Test of the Hypothesis That One of Two Random Variables Is Stochastically Larger than the Other
- P-280 On the Asymptotic Efficiency of Certain Nonparametric Two-sample Tests
- P-305 On the Detection of a Sine Wave in Gaussian Noise
- P-1474 The Goodness-of-fit Statistics of Kolmogorov and Smirnov
- P-2325 Tests of Homogeneity for Correlated Samples

STATISTICAL DECISION THEORY

- RM-753 A Statistical Theory of Target Detection by Pulsed Radar: Mathematical Appendix
- RM-754 A Statistical Theory of Target Detection by Pulsed Radar
- RM-2423 Use of Tolerance Limits in Missile Reliability Analysis
- RM-2601 Automatic Indexing: An Experimental Inquiry
- RM-2702 An Examination of the Use of Statistical Aggregates To Improve Management Control of Large Organizations
- RM-3021-PR Optimal Capacity Scheduling
- P-1160 Statistical Decision Theory as a Guide to Information Processing
- P-1396 Some Statistical Methods of Potential Value in Radio Wave Propagation Investigations
- P-1423 Use of Tolerance Limits in Missile Evaluation
- P-1843 Functional Equations in the Theory of Dynamic Programming—XI: Limit Theorems
- P-1993 A Heuristic Program for Assembly-line Balancing
- P-2067 Synchronization of Coherent Detectors
- P-2180 Automatic Indexing: An Experimental Inquiry
- P-2455 Information Retrieval: A Look at the Logical Framework and Some New Concepts
- P-2471 Probability and the Library Problem
- P-2487 The Design of a Sequential Test for the Detection of Known Signal in Normal Nonwhite Noise
- P-2495 Decisions, Communication, and Organization
- P-2498 Some Simple Examples of Singular Detection of Continuous Signals in Noise

- P-2502 Some Statistical Properties of Selected Inventory Models
- P-2517 A Brief Review of Inventory Theory
- P-2572 Design Principles for an Intelligent Machine

STRUCTURES—See also Aircraft and Missiles

DESIGN TECHNIQUES

- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-770 A Hypersonic Approximation of the Pressure Forces on Ogives
 - RM-1198 Proposal for Reduction of Factors of Safety for Military Airplanes
- RM-1633 Newtonian Flow Theory for Slender Bodies
- RM-1806 Report on the Dynamic Strength of Rigid-plastic Beams under Blast Loads
- RM-1963 Design Procedures and Data for Sandwich Panel Tests
- RM-2127 A Criterion for Choosing Sheet Tolerances in Aircraft Materials
- RM-2277 A Handbook for Estimating Material Requirements and Costs of Shelter Doors Subjected to Long-duration Blast Loading
- RM-2304 Bibliography of Literature on Optimum Design of Structures and Related Topics
- RM-2490-1 Thermoelectric Powerplants Utilizing Contained Nuclear Explosions
- RAOP-23 The Design of Constant-volume Missile Fuselages Having Minimum Drag at Supersonic Speeds
 - RAOP-33 Principles of Structural Design for Minimum Weight
- P-51 Effect of Creep on Column Deflection
 - P-82 Simplified Analysis of General Instability of Stiffened Shells in Pure Bending
 - P-695 Calculation of Hydrofoil Sections from Prescribed Pressure Distributions
 - P-1294 The Exploitation of the Strength of "Whiskers"
 - P-1675 Why Go Deep Underground?
 - P-1749 Discussion of Methods of Fatigue Analysis
 - P-1951 Weapons Effects for Protective Design
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
 - P-2331 Historical Note on the 1.5 Factor of Safety for Aircraft Structures
 - P-2476 A Systems Engineering Approach to Reliability
- RAT-2 Collection of Some German Data on Special Type Landing Gears
 - T-72 Excerpts from "Construction of Aircraft" (*Konstruktsii Samoletov*) Dealing with the Evolution and Uses of Soviet Airplanes

FATIGUE

- RM-413 The Expected Coverage of a Small Circular Target by a Number of Circular Bombs
- RM-1127 Fatigue Analysis of Aircraft Structures
 - RM-1198 Proposal for Reduction of Factors of Safety for Military Airplanes
- RM-1439 A Comparison of the FFA and RAND Methods of Fatigue Analysis
- RM-1476 A Proposed Mechanism of Fatigue Failure
 - RM-1518 A Test Program for Obtaining Basic Data on Creep-buckling Strength of Flat Plate Elements at Elevated Temperature
- RM-2011 On the Strength of Fine Wires
 - P-202 Principles of Creep Buckling
- P-350 A Theory of Fatigue Based on Unbonding During Reversed Slip
- P-641 Creep Buckling: An Engineering Survey
 - P-666 A Proposed Mechanism of Fatigue Failure
- P-920 On the Mechanism of Fatigue
 - P-1360 Elastic Equilibrium of a Plate with a Reinforced Elliptical Hole
 - P-1654 On the Strength of Fine Wires
 - P-1765 Laminated Metal-Ceramic Composite Materials

MATERIALS

- RA-15039 Ceramic Materials Research for Aircraft and Rocket Vehicles
- RA-15056 Ceramic Materials Research in the United Kingdom for Aircraft and Rocket Vehicles
- RA-15077 Short-time, High-temperature Properties of Heat-resisting Alloy Sheet

STRUCTURES—continued

MATERIALS—continued

- RA-15080 Titanium and Titanium-base Alloys
- RA-15081 Economic Survey: Selected Ferroalloy Metals for High-temperature Uses
- R-104 An Appraisal of the Usefulness of Aluminum Alloys for Supersonic Aircraft and Guided-missile Construction
- R-108 Calculations for Reactions of Chromium, Molybdenum, Titanium, and Tungsten with Oxygen, Nitrogen, Hydrogen, Carbon, and Sulfur
- R-116 Porous Ceramics for Transpiration Cooling
- R-117 An Evaluation of Ceramic Materials for Aircraft and Rocket Vehicles
- R-123 Calcium and Calcium-base Alloys
- R-131 Titanium and Titanium-base Alloys
- R-137 The Formation of Refractory Coatings by Vapor-deposition Methods
- R-146 The Effects of Temperature on the Mechanical Properties of Magnesium Alloys
- R-147 Short-time, High-temperature Properties of Heat-resisting Alloy Sheets
- R-200 Molybdenum Alloys and Protection by Cladding
- R-209 Mechanical Properties of Ceramic Bodies
- R-211 Composite Metal Sheets for Structural Applications
- RM-4 Thermodynamic Properties of Metals
 - RM-113 Evaluation of Materials in the Elasto-plastic Range
- RM-261 On the Thermodynamics of Solids: Critical Discussion of the Debye and Raman Theories with Applications
- RM-398 The Preparation of High-purity Boron
- RM-421 The Thermodynamic Properties of Silicon in the Solid, Liquid, and Gaseous States
- RM-524 Working Tables of Thermodynamic Functions and Equilibrium Constants for Silicon, SiO , and SiO_2
- RM-598 Preliminary Investigation of a Prestressed Ceramic Wing
- RM-770 A Hypersonic Approximation of the Pressure Forces on Ogives
- RM-1159 Behavior of Metals at High Rates of Loading
- RM-1160 An Approximate Theory of Armor Penetration
- RM-1693 Skin Temperature Variation during Re-entry of Scientific Satellite
- RM-1806 Report on the Dynamic Strength of Rigid-plastic Beams under Blast Loads
- RM-1868 Fibered Materials for Flight Structures
- RM-2011 On the Strength of Fine Wires
- RM-2127 A Criterion for Choosing Sheet Tolerances in Aircraft Materials
- RM-2180 Plastic Behavior of Thin Plates under Normal Pressure
- RM-2201 A Proposed Method for Obtaining Ductility in Beryllium by the Use of a Composite Arrangement
- RM-2222 Proposed Non-stoichiometric Ceramics
- RM-2263 On the Linear Relation between the Softening Temperature and the Melting Point of Ceramics
- RM-2277 A Handbook for Estimating Material Requirements and Costs of Shelter Doors Subjected to Long-duration Blast Loading
- RM-2314 Damage to X-ray Detectors by Meteorites
- RM-2341 Nickel, Columbium, Molybdenum, and Tungsten: A Preliminary Structural Comparison
- RM-2675 Minimum-weight Proportions of Pressure-vessel Heads
- RM-2915-PR The Titanium Decade
 - P-46 Arc Melting of Refractory Metals, Such as Titanium, and Their Alloys
 - P-53 Titanium-base Alloys
 - P-63 The Effect of Oxygen, Nitrogen, and Hydrogen on Iodide-refined Titanium
 - P-71 The Vapor-phase Deposition of Refractory Materials: General Conditions and Apparatus
- P-120 The Thermodynamic Properties of Boric Oxide and of Aluminum Oxide in the Ideal Gaseous State
- P-184 Forgeable Arc-melted Tungsten
- P-871 Beryllium as an Aircraft Structural Material

- P-1046 The Influence of Structural Materials on the Weight, Capability, and Cost of a Weapon System
- P-1073-AEC On the Compressibilities of Simple Metals
- P-1149 The Structural Exploitation of the Strength of "Whiskers"
- P-1294 The Exploitation of the Strength of "Whiskers"
- P-1307 Why Beryllium?
- P-1420 Materials for Space Flight
- P-1605 Optimum Tolerances of Sheet Materials for Flight Vehicles
- P-1606 The Linear Relation between the Softening Temperature and the Melting Point of Ceramics
- P-1654 On the Strength of Fine Wires
- P-1662 Effects of a Meteoroid Impact on Steel and Aluminum in Space
- P-1760 Future Possibilities in Fibered Material
- P-1765 Laminated Metal-Ceramic Composite Materials
- P-1974 The Effect of Filamentary Materials on Pressure-vessel Design
- P-1999 On University Courses in Materials for the Engineer
- P-2137 Minimum-weight Proportions of Pressure Vessel Heads
- P-2224 Correlation of Rock Properties by Statistical Methods
- P-2259 On the Ultimate Tensile Strength and Elongation of Ductile Materials
- P-2366 Improving the Mutual Guidance and Support between the Fields of Materials and Design

MISCELLANEOUS

- RA-15073 Eighth Quarterly Report—App. I: Materials, Fuels, and Combustion Project
- R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-1151 Response of Drag-type Structure to Blast
- RM-1401 The Strength of Anchor Bolts Set in Concrete
- RM-1518 A Test Program for Obtaining Basic Data on Creep-buckling Strength of Flat Plate Elements at Elevated Temperature
- RM-1895 Minimum-weight Design of Sandwich Panels
- RM-1963 Design Procedures and Data for Sandwich Panel Tests
- RM-2021 Notes on Linear Programming—Part XLII: Linear Programming and Structural Design
- RM-2998-PR Scabbing in Rock Tunnels
- P-68 Analysis of Stress-Strain-Time Relations from the Engineering Viewpoint
- P-101 Translability Flutter of Supersonic Aircraft Panels
- P-202 Principles of Creep Buckling
- P-218 Time-dependent Stress-Strain Distributions
- P-304 Thermal Stresses in Conical Shells
- P-361 A Method of Estimating the Compressive Strength of Optimum Sheet-stiffener Panels for Arbitrary Material Properties, Skin Thickness, and Stiffener Shapes
- P-498 A Method of Determining the Effects of Elevated Temperature on Structural Design and Weight
- P-946 Poisson's Ratio for Honeycomb Sandwich Cores
- P-1122 Linear Programming and Structural Design—I: Limit Analysis
- P-1123 Linear Programming and Structural Design—II: Limit Design
- P-1330 Poisson's Ratio for Honeycomb Sandwich Cores
- P-1628 Comments on Electrical Power Supplies for Underground Shelters
- P-1637 The Design of Large-area Astronautical Objects
- P-1676 The Cooling Problems of Chemical and Nuclear Power Plant Application to a Class of Large Shelters
- P-1762 Effects of Earthquakes on Tunnels
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
- P-2066 Surface Waves in an Elastic Half-space
- P-2109 Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium
- T-140 Calculation of the Heating of Two-layer Plates

STRUCTURES—continued

WEIGHT ESTIMATION

- RA-15018 Factors Limiting the Operational Gross Weight of the B-17 and B-29 Bombardment Airplanes: App. III to Fourth Quarterly Reports, RA-15033 and RA-15034
- R-172 Structural Weight Analysis: Fuselage and Shell Structures
- R-198 Structural Weight Analysis: Wing Weight Equations
- R-222 Weight-Strength Analysis of Aircraft Structures
- RM-391 Derivation of a Wing Weight Formula for a Thin Wing Structure
- RM-605 Weight Analysis of Thick-plate Wing Structures
- RM-1198 Proposal for Reduction of Factors of Safety for Military Airplanes
- RM-1624 Weight-feasibility Calculation for Shielding of Truck Passengers
- RM-1796 On the Optimization of Two-stage Rockets
- RM-1868 Fibered Materials for Flight Structures
- RM-1895 Minimum-weight Design of Sandwich Panels
- RM-2277 A Handbook for Estimating Material Requirements and Costs of Shelter Doors Subjected to Long-duration Blast Loading
- P-89 Minimum Weight of Stiffened Cylindrical Shells in Pure Bending
- P-124 Effect of Torsional Stiffness Requirements on Wing Structural Weight
- P-205 Applications of Optimum Design Principles to Structural Weight Estimation
- P-1214 A Study of Turbojet Engine Weight
- P-1636 Some Weight Considerations for Manned Lunar Missions

SYSTEMS ANALYSIS—See also Economics

- R-346 The Economics of Defense in the Nuclear Age
- R-353 On the Epistemology of the Inexact Sciences
- RM-388 Human Factors in Systems Analysis
- RM-1434-RC Bargaining: The Hidden Hand in Government
- RM-1678 An Introduction to Systems Analysis
- RM-1829 Techniques of Systems Analysis
- RM-1937 Ten Common Pitfalls
- RM-2240 Complements and Substitutes in the Optimal Assignment Problem
- RM-2399 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- RM-2413 War Gaming Methodology
- RM-2415 The Flight Operations Planner
- RM-2471 A Preliminary-design Aid for Studying Component Weight Assignments in Ballistic-missile Payloads
- RM-2473-FF Systems Analysis and Education
- RM-2483 The Design of Complex Management Control Systems
- RM-2525 Addendum to RM-2415, *The Flight Operations Planner*
- RM-2735-PR Operational Criteria for the Design of Missile Readiness Testing Programs and Equipment
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-2858-PR The Nature of Research Goals: Some Necessary Definitions
- P-326 Suboptimization in Operations Problems
- P-386 Suboptimization Criteria and Operations Research
- P-526 Nonmilitary Applications of Operations Research
- P-537 Systems Engineering
- P-694 The Role of Management Tools in Making Military Decisions
- P-699 An Appreciation of Systems Analysis
- P-870 Professor Koopmans on Fallacies: A Comment
- P-880 Weapons System Philosophy
- P-1030 Operations Research: A New Science?
- P-1032 Scientific Aids to Decisionmaking: A Perspective

- P-1035 What Is a System?
- P-1042 Scientific Aids to Decisionmaking: A Perspective
- P-1165 Monte Carlo
- P-1166 Game Theory
- P-1167 War Gaming
- P-1250 Economics and Military Operations Research
- P-1254 An Electronics Engineer's View of Operations Research
- P-1362 Design of a Management Information System
- P-1493 Toward a New Weapon-system Analysis
- P-1513 On the Epistemology of the Inexact Sciences
- P-1521 Reliability Estimating by the Use of Random Sampling Simulation
- P-1526 Sequencing n Jobs on Two Machines with Arbitrary Time Lags: Alternate Proof and Discussion of General Case
- P-1530 Systems Analysis versus Systems Design
- P-1592 A Game Theory Analysis of Tactical Air War
- P-1601 RAND: A Personal View of Its History
- P-1685 The Aggregation of Servicing Facilities in Queueing Processes
- P-1692 The Content of Economics
- P-1694 Pitfalls in Analysis
- P-1725 Experimental Design, Test, and Evaluation of an F-100D Flyaway Kit
- P-1758 A Further Comment on Economics and Operations Research
- P-1773 An Introduction to War Games
- P-1779 What Do We Mean by "Research and Development"?
- P-1783 Systems Design for Management Automation
- P-1826 A Structural Approach to Military Air Transportation
- P-1833 The Simple Mathematics of Maximization
- P-1839 Ballistic-missile Payload Allocation
- P-1840 The Contextual Study: A Structured Approach to the Study of Political and Military Aspects of Limited War
- P-1854-RC The Link between Science and Invention: The Case of the Transistor
- P-1856-RC Economic Welfare and the Allocation of Resources for Invention
- P-1865 On the Future of Operations Research in the Aircraft and Space Systems Industries
- P-1867 How Much Automaticity for Checkout Equipment
- P-1883 Comments on Some Aspects of Corporate Planning in the Defense Industry
- P-1901-RC Strategy and Organization in a System Development Project
- P-1914 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- P-1916 The Decisionmaking Problem in Development
- P-1942 Some Analytical Techniques for Personnel Planning
- P-1945 Development of Man-Machine Simulation Techniques
- P-1955 On the Choice of Objectives in Systems Studies
- P-1959 Uncertainties in Operations Research
- P-1982 Economic Development, Research and Development, Policymaking: Some Converging Views
- P-2072 The Implications of Some Game-theoretic Analyses for War Gaming
- P-2073-RC Introduction to the UNBER-SSRC Conference Volume on Inventive Activity
- P-2089-3 Research and Economic Growth: The Role of Public Policy
- P-2107 Appraising Soviet Astronautics
- P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
- P-2135 Identifying R&D: A Management Problem
- P-2147 The Nature and Function of Military R&D
- P-2174 On the Uses of Economics: Theory, Policy, and Values
- P-2179-RC The Uses of Economics
- P-2183 The Crude Analysis of Strategic Choices
- P-2184 Complements and Substitutes in the Optimal Assignment Problem
- P-2222 New Tools for Planners and Programmers
- P-2260 How Useful Are "Scientific" Tools of Management?
- P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
- P-2289 Utilization of Social Research in Shaping Policy Decisions

SYSTEMS ANALYSIS—continued

- P-2319 Some Limitations of Automatic Test Equipment
- P-2445 The Role of the Accountant in Operations Analysis
- P-2462-1 Science and Statecraft
- P-2476 A Systems Engineering Approach to Reliability
- P-2511 Scheduling State of the Art: Anathema or Necessity?
- P-2538 A Game Theoretic Approach to Space Vehicle Prelaunch Activities Scheduling
- P-2568 Technological Change and Local Economy
- P-2574 Problems of Support Planning

TARGETS—See also Bombing, Defense Studies, Offense Studies, and Operations

DAMAGE ASSESSMENT AND CRITERIA

- RM-517 Expected Results of a Bombing Strike, Including Reconnaissance
- RM-522 Curves Giving Expected Results of a Bombing Strike
- RM-1151 Response of Drag Type Structure to Blast
- RM-1632 Expected Damage from Single and Multiple Bombs to Targets Distributed Uniformly around a Circle
- RM-1806 Report on the Dynamic Strength of Rigid-plastic Beams under Blast Loads
- RM-2715 Structures under Repeated Blast Loadings
- RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- RM-2844-PR Postattack Damage Assessment: A Conceptual Analysis
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options
- P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
- P-2414 Problems of Fire in Nuclear Warfare

MISCELLANEOUS

- RM-189 Note on Some Historic Principles of Target Selection
- RM-727 The Use of Experts for the Estimation of Bombing Requirements: A Project Delphi Experiment
- RM-815-1 Population of Major Cities of the USSR
- P-438 The Vulnerability of the United States to Enemy Attack: Elements of an Unclassified Research Program in the Social Sciences
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options

WARFARE—See Defense Studies, Offense Studies, Operations, and Targets

PART II

REPORTS

SM-11827 (out of print). **Preliminary design of an experimental world-circling space ship.** Staff. 5-2-46. Unclassified.

An engineering analysis of the possibilities of designing an earth-circling satellite vehicle. The analysis considers power plants, structural weights, multiple stages, optimum design values, trajectories, stability, and landing. 324 pp. Illus.

RA-15005 (out of print). **The interim study.** L. E. Root. 9-1-46. Unclassified.

An evaluation of the possibilities and limitations of current or nearly developed new weapons. The factor of range is studied, together with the factors controlling absolute performance expected from multiengined aircraft with reciprocating engines. 27 pp. Illus.

RA-15006 (out of print). **Status of satellite study.** J. E. Lipp. 9-1-46. Unclassified.

Progress report on aerodynamics, flight mechanics, structures, weights, fuels, control, and meteorology aspects of satellite study. 15 pp. Illus.

RA-15008 (out of print). **Effect on military worth of exchanging bombing accuracy for bomber safety by increasing range of bomb.** J. D. Williams. 9-1-46. Unclassified.

An analysis of bombing accuracy versus bomber safety. The various theories presented show the effect (1) of releasing the bomb from a lesser distance to increase bombing accuracy and (2) of releasing the bomb from a greater distance to increase bomber safety. 54 pp. Illus.

● **RA-15015. A problem in logistics: the jeep problem.** Olaf Helmer. 12-1-46. Unclassified.

A formulation of a problem in logistic strategy which deals with the delivery of a long-range attack by a vehicle of limited range. The basic jeep problem is generalized step by step in an effort to approach realistic conditions of air strategy. 5 pp. Illus.

RA-15016 (out of print). **An analysis of the guided missile-strategic bomber interception problem: app. II to fourth quarterly reports, RA-15033 and RA-15034.** C. V. Sturdevant III. 3-1-47. Unclassified.

A study to determine the bomber modifications necessary to reduce vulnerability to antiaircraft guided missiles. The following factors affecting a bomber's vulnerability are discussed: (1) the magnitude of evasive accelerations, (2) the timing of evasive maneuvers, and (3) the speed of the bomber. 32 pp. Illus.

RA-15018 (out of print). **Factors limiting the operational gross weight of the B-17 and B-29 bombardment airplanes: app. III to fourth quarterly reports, RA-15033 and RA-15034.** Boeing Aircraft Company. 3-1-47. Unclassified.

A discussion of several factors which limit the operational gross weight of the B-17 and the B-29 bombardment airplanes. Those factors presented are (1) the capacity of the bomb bay and operating ceiling of the airplane, (2) the take-off and climb performance, (3) the engine cooling limitations, (4) the climatic and terrain conditions, (5) the partial engine performance, and (6) the airplane strength factors. 26 pp. Illus.

● **RA-15019. A problem in logistics: the jeep problem (part 2)—app. IV to fourth quarterly report, RA-15033.** Olaf Helmer. 3-1-47. Unclassified.

A mathematical treatment of the problem of determining the location of a single intermediate base for the use of a vehicle of limited range engaged in long-range deliveries. The schedule of operations which require the least time or least fuel is explored. 11 pp. Illus.

RA-15021 (out of print). **Flight mechanics of a satellite rocket.** R. W. Krueger, G. Grimminger, and E. Tieman. 2-1-47. Unclassified.

A study of the optimum trajectory for a three-stage satellite rocket. A discussion of (1) various parameters upon which the trajectory performance depends, (2) accurate equations of motion, and (3) a method of integration. 89 pp. Illus.

RA-15022 (out of print). **Aerodynamics, gas dynamics, and heat transfer problems of a satellite rocket.** R. W. Krueger and G. Grimminger. 2-1-47. Unclassified.

An evaluation of satellite rocket problems which involve the motion of high-speed gases. These include the flow over the external surface of the rocket (drag), the flow through the rocket motor, and the heat transfer and skin temperatures of the satellite. 82 pp. Illus.

RA-15027 (out of print). **Satellite rocket powerplant.** J. O. Crum and S. L. Gendler. 2-1-47. Unclassified.

A consideration of the requirements of a satellite-vehicle powerplant. The requirements of the main thrusting and guiding rocket motors and the auxiliary power supply are dealt with separately. 110 pp. Illus.

RA-15028 (out of print). **Communication and observation problems of a satellite.** D. K. Bailey and A. S. Mengel. 2-1-47. Unclassified.

A report on the instrumentation necessary for communication between ground stations and a man-made satellite on an orbit above the earth's equator. The means to determine the position-yielding observations of the satellite are also discussed. 90 pp. Illus.

RA-15029 (out of print). **Study of launching sites for a satellite projectile.** J. E. Lipp and D. K. Bailey. 2-1-47. Unclassified.

A discussion of the factors involved in the choice of a launching site for the first experimental satellite. Reasons are adduced for the launching eastward from some point within 2° latitude of the equator. 49 pp. Illus.

RA-15031 (out of print). **Proposed type specification for an experimental satellite.** J. E. Lipp. 2-1-47. Unclassified.

A statement of the design requirements for an unmanned satellite vehicle. These include (1) the basic rocket, (2) the payload, and (3) the necessary ground and launching equipment. The characteristics of a satellite which could achieve an experimental mission with a minimum of research, development, construction costs, and elapsed time are also described. 10 pp. Illus.

RA-15032 (out of print). **Reference papers relating to a satellite study.** J. E. Lipp. 2-1-47. Unclassified.

A selection of memoranda on the value of a satellite vehicle and technical problems likely to be encountered in its development. 49 pp. Illus.

RA-15033 (out of print). **Fourth quarterly report—special issue—limited circulation.** 3-1-47. Unclassified.

RA-15035 (out of print). **First annual report.** 3-1-47. Unclassified.

RA-15036 (out of print). **Fifth quarterly report—special issue—limited circulation.** 6-1-47. Unclassified.

RA-15037 (out of print). **Fifth quarterly report.** 6-1-47. Unclassified.

RA-15039 (out of print). **Ceramic materials research for aircraft and rocket vehicles.** Battelle Memorial Institute. 8-26-47. Unclassified.

A survey of the research and development of ceramic materials in the United States. Several phases discussed are (1) the administrative details of government-sponsored research, (2) the technical aspects of ceramic components for use in aircraft and rocket vehicles, and (3) data on preparation and properties of ceramic bodies and coatings. 89 pp. Illus.

RA-15042 (out of print). **Propellants for supersonic vehicles: boron compounds.** Battelle Memorial Institute. 10-8-47. Unclassified.

A report on the chemical and physical properties, methods of synthesis, handling, storage, and performance of boron compounds as potential propellants for supersonic vehicles. 62 pp. Illus.

RA-15044 (out of print). Propellants for supersonic vehicles: liquid oxygen. Battelle Memorial Institute. 3-15-48. Unclassified.

A report on liquid oxygen as the cheapest and most easily handled high-performance oxidizer. The chemical and physical properties, manufacturing methods, handling, storage, and performance of liquid oxygen are discussed, together with its advantages and disadvantages for use in supersonic vehicles. 36 pp. Illus.

RA-15046 (out of print). Propellants for supersonic vehicles: hydrogen peroxide. Battelle Memorial Institute. 8-12-47. Unclassified.

A report on hydrogen peroxide as an oxidizer in rocket-propulsion applications. The chemical and physical properties, manufacturing methods, production, availability, handling, storage, and performance of this oxidizer are discussed. 23 pp. Illus.

RA-15047 (out of print). Propellants for supersonic vehicles: liquid fluorine. Battelle Memorial Institute. 8-12-47. Unclassified.

The chemical and physical properties, manufacturing methods, handling, storage, and performance of liquid fluorine as a rocket fuel. 27 pp. Illus.

RA-15048 (out of print). Propellants for supersonic vehicles: halogen fluorides. Battelle Memorial Institute. 8-12-47. Unclassified.

The chemical and physical properties, manufacturing methods, production, availability, handling, storage, and performance of halogen fluorides as a rocket fuel. 11 pp. Illus.

RA-15052 (out of print). Sixth and seventh quarterly report—special issue—limited circulation. Staff. 12-1-47. Unclassified.

RA-15053 (out of print). Sixth and seventh quarterly report. Staff. 12-1-47. Unclassified.

RA-15056 (out of print). Ceramic materials research in the United Kingdom for aircraft and rocket vehicles. Battelle Memorial Institute. 11-24-47. Unclassified.

A survey of the research and development of ceramic materials applicable to aircraft and missiles in the United Kingdom as of April, 1947. 30 pp. Illus.

RA-15068 (out of print). Propellers for high-speed long-range airplanes. L. E. Root and R. S. Schairer. 1-12-48. Unclassified.

A brief analysis of the parameters which determine range with estimates of optimum values obtainable in the near future. From these data the relative performance of turbojet, turboprop, and conventional reciprocation engine-propeller drives for long-range high-speed aircraft are appraised. 5 pp. Illus.

RA-15071 (out of print). Eighth quarterly report—special issue—limited circulation. Staff. 3-1-48. Unclassified.

RA-15072 (out of print). Eighth quarterly report. Staff. 3-1-48. Unclassified.

RA-15073. Eighth quarterly report—app. I: materials, fuels, and combustion project. Battelle Memorial Institute. 2-16-48. Unclassified.

A progress report on the limitations of commercially available materials for supersonic vehicle construction, unconventional materials for extreme service conditions, and the effectiveness of thin insulating coatings in increasing the performance of sheet metal materials for skins. An evaluation of the materials and methods for transpiration cooling, the propellants and the motor combustion for supersonic vehicles, and the economics of construction materials and propellants. 23 pp. Illus.

- **RA-15074. Evaluation of missile drift caused by wind.** R. H. Dishington and W. W. Kellogg. 4-12-48. Unclassified.

An evaluation of the effect of wind on gliding missiles in free flight for diversified values of altitude, range, velocity, and missile configuration. Curves, showing total drift as a function of time, are plotted for a specific, typical missile at various initial speeds and constant altitudes. 19 pp. Illus.

RA-15075. Second annual report. 3-1-48. Unclassified.

RA-15077 (out of print). Short-time, high-temperature properties of heat-resisting alloy sheet. Battelle Memorial Institute. 2-27-48. Unclassified.

An analysis of a laboratory evaluation program on short-time, high-temperature properties of sheet-metal materials now commercially available. To date, tests have been run at 1200°, 1500°, and 1800°F on 18Cr-8Ni steel, 18Cr-8Ni steel (Columbium stabilized), 25Cr-20Ni-2Si, Inconel, Hastelloy C, and Stellite 21. 36 pp. Illus. See R-147 (out of print).

- **RA-15078 (out of print). Contributions to Lanchester attrition theory. R. N. Snow. 4-5-48. Unclassified.**

A mathematical model of warfare, representing a series of elementary combats by a set of differential equations. The case of battle (or war) is generalized between two sets of heterogeneous forces. The possible form of attrition equations is considered without assuming a common unit of measure between component forces. 33 pp. Illus.

RA-15079. Economic survey: the potential production of anhydrous hydrazine, propellant for supersonic vehicles. Battelle Memorial Institute. 3-10-48. Unclassified.

A study of the economic feasibility of large-scale hydrazine production by the Raschig process and a hypothetical vapor-phase ammonia-oxidation process and examinations of the impact of such production on the present basic chemicals industry. 19 pp. Illus.

RA-15080 (out of print). Titanium and titanium-base alloys. Battelle Memorial Institute. 4-2-48. Unclassified.

A study of the availability of titanium ores, the present status of titanium metal production. The results of a laboratory evaluation of metallic titanium and titanium-base alloys are presented. 69 pp. Illus. See also R-131.

RA-15081. Economic survey: selected ferroalloy metals for high-temperature uses. Battelle Memorial Institute. 4-1-48. Unclassified.

An economic survey of construction materials with favorable high-temperature properties for use in aircraft and guided missiles. The ferroalloy metals studied are (1) chromium, (2) cobalt, (3) columbium, (4) molybdenum, (5) nickel, and (6) tungsten. 69 pp. Illus.

- **RA-15088. A table of vibrational contributions of a harmonic oscillator to thermodynamic functions. F. J. Krieger. 7-1-48. Unclassified.**

An analysis of a table which facilitates the calculation of the electronic and vibrational contributions of a harmonic oscillator to the thermodynamic functions. 40 pp. Illus.

- **R-104 (ATI 48050) (out of print). An appraisal of the usefulness of aluminum alloys for supersonic aircraft and guided-missile construction. Battelle Memorial Institute. 8-8-48. Unclassified.**

An appraisal of aluminum for use in supersonic vehicles. Data are given on the effect of low and high temperatures on the mechanical properties of aluminum. Electrical conductivity, thermal conductivity, thermal expansion, and corrosion of aluminum exposed to various rocket propellants are also given. 231 pp. Illus.

R-106 (ATI 44567). New York Conference of Social Scientists. 6-9-48. Unclassified.

A verbatim record of the New York Conference of Social Scientists in September, 1947. The first step in initiating a RAND social science program. 334 pp.

- Ø **R-108 (ATI 52206) (out of print). Calculations for reactions of chromium, molybdenum, titanium, and tungsten with oxygen, nitrogen, hydrogen, carbon, and sulfur. Battelle Memorial Institute. 7-19-48. Unclassified.**

A report on theoretical applications of physical-chemical data by which the conditions for reactions of refractory metals with atmospheric gases are determined. 90 pp. Illus.

- **R-109 (ATI 44566). A decision method for elementary algebra and geometry.** Alfred Tarski. 8-1-48. Rev. May 1951. Unclassified.

A decision method by which the truth of sentences of the elementary algebra and geometry of real numbers is determined. 60 pp. Illus.

- R-114 (ATI 43593) (out of print). Effects of flight speed and propulsive system on aircraft range.** Richard Schamberg. 8-13-48. Unclassified.

An investigation of flight-speed and propulsive-system-capability effects on aircraft range. The basic concepts employed are applicable to all airplane flight speeds and to propulsive systems operating with various fuels whose potential energy is released by chemical or nuclear reaction. 93 pp. Illus.

- **R-115 (ATI 54800) (out of print). Mathematical theory of zero-sum two-person games with a finite number or a continuum of strategies.** Melvin Dresher. 9-3-48. Unclassified.

A summarization of zero-sum two-person games with a finite number of strategies. 47 pp.

- R-116 (ATI 55021). Porous ceramics for transpiration cooling.** Battelle Memorial Institute. April 1949. Unclassified.

A formulation of a theory and requirements for transpiration cooling using ceramic materials. A partial experimental evaluation of commercial ceramic filter media and of experimental bodies having desirable porous structures. 51 pp. Illus.

- R-117 (ATI 52488) (out of print). An evaluation of ceramic materials for aircraft and rocket vehicles.** Battelle Memorial Institute. 3-17-49. Unclassified.

An evaluation of ceramic materials for aircraft and rocket applications, including gas turbines, rocket motors, ramjet and pulsejet engine walls, skin coatings for supersonic vehicles, and porous ceramics for transpiration cooling. 31 pp. Illus.

- R-121 (ATI 45503). Economic survey: the potential availability of ammonia, nitric acid, and nitrogen tetroxide, propellants for supersonic vehicles.** Battelle Memorial Institute. 12-20-48. Unclassified.

A study of the availability and approximate cost of nitrogen-containing compounds for rocket propulsion. Under the assumption that large quantities of propellants may be used in supersonic vehicles, the impact of this requirement on the United States economy is evaluated. 22 pp. Illus.

- R-123 (ATI 55092) (out of print). Calcium and calcium-base alloys.** Battelle Memorial Institute. 1-1-49. Unclassified.

A survey of calcium and calcium-base alloys as possible construction materials for aircraft and guided missiles. 62 pp. Illus.

- R-124 (ATI 56114). Economic survey: the potential production of liquid fluorine, chlorine trifluoride, and other fluorine compounds, propellants for supersonic vehicles.** Battelle Memorial Institute. 4-18-49. Unclassified.

An evaluation of the availability and approximate cost of producing elemental fluorine, chlorine trifluoride, and other propellants containing fluorine. Assuming that large volumes of these propellants may be used in a rocket vehicle program, the economic impact of this requirement on fluorine mineral producing and consuming industries is estimated. 42 pp. Illus.

- **R-127 (ATI 62047). Physical properties and thermodynamic functions of fuels, oxidizers, and products of combustion—I: fuels.** Battelle Memorial Institute. January 1949. Unclassified.

A compilation of the physical properties and thermodynamic functions of thirty-four potential rocket fuels. 300 pp. Illus. See also R-129 and R-196.

- **R-129 (ATI 62046). Physical properties and thermodynamic functions of fuels, oxidizers, and products of combustion—II: oxidizers.** Battelle Memorial Institute. February 1949. Unclassified.

A description of the physical properties and thermodynamic functions of thirteen chemical elements and compounds which might be useful as oxidizers in rocket-propelled vehicles. 92 pp. Illus. See also R-127 and R-196.

- **R-130 (ATI 64980) (out of print). An approximate method for the calculation of airplane radius factor.** Richard Schamberg. 2-3-49. Unclassified.

A method for determining an airplane radius factor which is defined as the ratio of the operational or combat radius of an airplane to its all-out range. The concepts presented are applicable to all types of airplanes and missions. Specific calculations of radius factors are included for bombers with several engine types illustrating how the radius factor varies with payload and fuel load as well as with the specifications for the mission and operation of the airplane. 20 pp. Illus.

- **R-131 (ATI 54314). Titanium and titanium-base alloys.** Battelle Memorial Institute. 3-15-49. Unclassified.

An appraisal of the value of titanium metal and titanium-base alloys as materials of construction. A study of ore reduction processes, alloy preparation methods, properties and fabricating characteristics of titanium and titanium-base alloys. 158 pp. Illus. See also RA-15080 (out of print).

- R-132 (ATI 88205) (out of print). Scattering and absorption of gamma rays and neutrons.** M. S. Plesset and S. T. Cohen. 3-1-49. Unclassified.

A formulation of the scattering and absorption of gamma rays and neutrons. Principal attention is given to the transmission of gamma rays. The range of gamma-ray energies considered is from 1 to 10 MC². Results are given for the transmission of gamma rays through air and lead. 27 pp. Illus.

- R-134. Third annual report.** 3-1-49. Unclassified.

- R-136 (ATI 54799). Effect of missile dynamics on flight path.** R. H. Frick. 3-2-49. Unclassified.

A method to determine the variations in the flight path of a missile from inclusion of the effects of rotation about the center of gravity. Applicable to the motion of a controlled missile for power-on or power-off operation, this theory is developed as a perturbation of the steady-state flight path equations. 17 pp. Illus.

- R-137 (ATI 68284) (out of print). The formation of refractory coatings by vapor-deposition methods.** Battelle Memorial Institute. 3-25-49. Unclassified.

A summary of vapor-deposition methods for coating simple refractory materials and properties of these coatings. Materials included are refractory metals, carbides, silicides, borides, nitrides, and oxides. 97 pp. Illus.

- R-141 (ATI 63026) (out of print). A two-dimensional airfoil in unsteady supersonic flow.** Alexander Wyly. 1-20-49. Unclassified.

A presentation of simplified airfoil lift solutions. Several conditions affecting this surface are analyzed: (1) a sudden change in angle of attack, (2) a constant and changing rate of angle of attack, (3) a harmonic oscillation, (4) sudden change in forward velocity, and (5) a constant forward acceleration. 63 pp. Illus.

- R-142 (ATI 68283). Mixing in inhomogeneous gas jets.** Battelle Memorial Institute. February 1949. Unclassified.

An analysis of a freely expanding turbulent jet. A comparison is made between theoretical values and preliminary experimental data from jets of helium, nitrogen, and carbon dioxide obtained by micro-sampling and impact pressure surveys. 25 pp. Illus.

- **R-144 (ATI 62856). Theory of blind navigation by dynamical measurements.** J. J. Gilvarry and S. H. Browne. 7-14-49. Unclassified.

A discussion of the theory of blind navigation by means of dynamical measurements (measurements of forces or accelerations) with a reference frame inside the vehicle. An intervalwise solution for trajectories of extended range, based on the use of a linear approximation in each interval, is described and applied in a practical case. 35 pp. Illus.

- **R-146 (ATI 66546). The effects of temperature on the mechanical properties of magnesium alloys.** Battelle Memorial Institute. October 1949. Unclassified.

A study of temperature effects on magnesium alloy properties. The characteristics described that dictate its selection are workability, weldability, corrosion, specific gravity, and conductivity. The temperature effect on tensile creep, fatigue properties, and room-temperature properties is also presented. 210 pp. Illus.

- R-147 (ATI 65076) (out of print). Short-time, high-temperature properties of heat-resisting alloy sheet.** Battelle Memorial Institute. June 1949. Unclassified.

A report on the short-time high-temperature tension and creep properties of varieties of commercially available sheet materials used in supersonic vehicles. The materials range from magnesium- and aluminum-base alloys in the lower-temperature ranges to the strongest heat-resisting alloys for high-temperature service. 80 pp. Illus. See RA-15077 (out of print).

- R-149 (ATI 65491) (out of print). The composition and thermodynamic properties of air at temperatures from 500 to 8000°K and pressures from 0.00001 to 100 atmospheres.** W. B. White and F. J. Krieger. 4-15-49. Unclassified.

A study of heating supersonic vehicles aerodynamically. The equilibrium composition, molecular weight, specific total enthalpy, and specific entropy of air, considered a perfect gas mixture, are computed at temperatures from 500 to 8000°K and pressures from 0.00001 to 100 atmospheres, for use in problems of aerodynamic heating of supersonic vehicles. 10 pp. Illus. See RM-1543.

- **R-154 (ATI 166662) (out of print). Theory of errors in automatic navigation with integrating accelerometer systems.** S. H. Browne and J. J. Gilvarry. 5-5-52. Unclassified.

General definitions of the errors in navigation systems in which position is computed by integration of accelerations measured within a vehicle in flight. The differential equations satisfied by the errors in computed position are derived, and the nature of their solutions for certain special cases is examined. 25 pp. Illus.

- R-156 (ATI 63914) (out of print). Economic survey: the potential production of diborane, pentaborane, and aluminum borohydride, propellants for supersonic vehicles.** Battelle Memorial Institute. 5-15-49. Unclassified.

An evaluation of the potential supply of raw materials for boron fuels which might be used in guided missiles. The economic limitations on possible future production of diborane, pentaborane, and aluminum borohydride are reviewed, together with a description of the boron and lithium-producing and consuming industries. 46 pp. Illus.

- R-157 (ATI 69331) (out of print*). The frequency of mental disease: long-term trends and present status.** H. Goldhamer and A. W. Marshall. July 1949. Unclassified.

A presentation of time series of admission rates to mental hospitals for different age groups since 1840 for the purpose of evaluating the serious social, military, and economic implications of a possible increase in the frequency of mental disorders. Sources and methods of computation used are discussed. A second part presents a simple measure of the risk of admission to a mental hospital. 77 pp. Illus. Published as *Psychosis and Civilization*, The Free Press, Glencoe, Illinois, 1953. \$4.00.

- R-165 (ATI 65308) (out of print). Notes on strategic air intelligence in World War II (ETO).** Carl Kaysen. October 1949. Unclassified.

A discussion of strategic air intelligence, its aims and its sources. From the evaluation of intelligence experience in World War II, several recommendations regarding analysis methods, personnel, and research technique are presented. 32 pp.

R-170 (ATI 74301) (out of print). Gamma-ray absorption coefficients. R. Latter and H. Kahn. 9-19-49. Unclassified.

A presentation in convenient tabular and graphic form of the latest theoretical information on gamma-ray absorption and scattering coefficients and certain related functions. 71 pp. Illus.

R-172 (ATI 81997). Structural weight analysis: fuselage and shell structures. W. R. Micks. January 1950. Unclassified.

Incorporated in R-222 (out of print).

- **R-181 (ATI 91182). Long-range surface-to-surface rocket and ramjet missiles: aerodynamics.** E. P. Williams, L. W. Dhanes, J. H. Huntzicker, R. J. Lew, H. A. Lieske, L. L. Moore, and G. B. W. Young. First printing 5-1-50. Second printing April 1959. Unclassified.

A presentation of the aerodynamic considerations and methods involved in determining the optimum long-range surface-to-surface missiles, with emphasis given the final-stage configurations where the aerodynamic parameter of predominant importance is maximum lift-drag ratio. 187 pp. Illus.

R-193 (ATI 194390) (out of print*). Activity analysis of production and allocation (proceedings of a conference). Cowles Commission. June 1951. Unclassified.

Superseded by *Activity Analysis of Production and Allocation*, ed. by T. C. Koopmans, John Wiley & Sons, Inc., New York, 1951. \$4.50.

- **R-196 (ATI 93134). Physical properties and thermodynamic functions of fuels, oxidizers, and products of combustion—III: products of combustion.** Battelle Memorial Institute. 9-1-49. Unclassified.

A presentation of a compilation of data on the physical properties and thermodynamic functions of products of combustion of rocket propellants. In addition to the data for reaction products commonly encountered, thermodynamic data have been obtained for minor components which become important at higher reaction temperatures. 181 pp. See also R-127 and R-129.

- **R-197 (ATI 121373) (out of print). A dollar index of Soviet machinery output, 1927–28 to 1937.** Alexander Gerschenkron. 4-6-51. Unclassified.

The construction of a dollar index of machinery output in the Soviet Union from 1928 to 1937 to determine the rate of growth of Russian industrial output for this period. In addition, problems involved in constructing such an index are discussed. 357 pp. Illus. See also RM-804, RM-1042, and RM-1055.

R-198 (ATI 92419). Structural weight analysis: wing weight equations. W. R. Micks. December 1950. Unclassified.

Incorporated in R-222 (out of print).

R-199 (ATI 117330) (out of print). Soviet attitudes toward authority. Margaret Mead. January 1951. Unclassified.

A preliminary report on approved and disapproved attitudes toward authority in the Soviet Union as they have developed during the last twenty years. This study is directed toward the development of hypotheses on the state of the USSR during the next five to ten years. 148 pp. Also published as *Soviet Attitudes toward Authority* (out of print), McGraw-Hill Book Company, Inc., New York, 1951. \$4.00.

- **R-200 (ATI 97773). Molybdenum alloys and protection by cladding.** Battelle Memorial Institute. 4-25-50. Unclassified.

A two-part report on molybdenum and molybdenum-base alloys prepared by powder-metallurgy techniques, and the cladding of molybdenum. The purpose of Part I is to furnish engineering properties of wrought sheet molybdenum and some of its alloys. Part II evaluates the processing and properties of three kinds of commercially available molybdenum clad with a variety of potentially useful cladding materials. 158 pp. Illus.

- **R-201 (ATI 135284) (out of print). The organizational weapon: a study of bolshevik strategy and tactics.** Philip Selznick. January 1952. Unclassified.
An analysis of communist organizational strategy as applied in bolshevik type of party and the peripheral or "front" organizations manipulated by it. In addition, the strategy and tactics of political combat, whereby labor unions and other voluntary associations and institutions become organizational targets for communist penetration and control, are discussed. 353 pp. Also published as *The Organizational Weapon* (out of print), McGraw-Hill Book Company, Inc., New York, 1952. \$5.50.
- R-203 (ATI 95416) (out of print). Chemical kinetics and rocket nozzle design.** F. J. Krieger. 8-15-50. Unclassified.
A report of an investigation of the effect of chemical kinetics on rocket nozzle design for the particular case of hydrogen gas flowing adiabatically through a typical rocket nozzle having a chamber-to-throat area ratio of 2 to 1. Three types of flow are compared. 32 pp. Illus.
- **R-206 (ATI 98024) (out of print). The operational code of the Politburo.** N. C. Leites. 8-1-50. Unclassified.
A short guide to Politburo behavior, summarizing the provisional findings of a continuing investigation of the political strategy of bolshevism based on the writings of Lenin and Stalin. The intention is not to discuss the major theories of Leninism-Stalinism, but to discover the rules which bolsheviks believe to be necessary for effective political conduct. 115 pp. See R-239 (out of print). Also published as *The Operational Code of the Politburo*, McGraw-Hill Book Company, Inc., New York, 1951. \$3.00.
- **R-209 (ATI 98023). Mechanical properties of ceramic bodies.** Battelle Memorial Institute. 8-31-50. Unclassified.
The first phase of a fundamental program on the load-bearing characteristics of ceramic bodies. The room-temperature compression, tension, and shear data on porous and nonporous specimens of a normal porcelain are given. 33 pp. Illus.
- R-210 (ATI 98991). A study of Project SCOOP linear programming.** R. W. Shephard and W. W. Baldwin. 3-1-51. Unclassified.
A discussion of (1) the methods and techniques of SCOOP linear programming, (2) the official determination of logistic requirements in the Department of Defense, (3) the theoretical framework of the linear model of interindustry economics, and (4) the present status of research to adapt this model to the programming of military requirements in the national economy. 135 pp. Illus.
- R-211 (ATI 99742). Composite metal sheets for structural applications.** Battelle Memorial Institute. 6-30-50. Unclassified.
A theoretical evaluation of various metals and alloys to establish the optimum ratio of cladding thickness to total thickness which affords the minimum weight for a given rigidity. 44 pp. Illus.
- R-212 (ATI 117329) (out of print*). Air war and emotional stress: psychological studies of bombing and civilian defense.** I. L. Janis. 6-1-51. Unclassified.
A study of the psychological effects of air warfare based on observations of civilian reactions to bombing in England and Germany and at Hiroshima and Nagasaki after the first A-bomb was dropped. This report indicates the nature of the problems which may arise in planning civilian defense of the United States. 280 pp. Illus. See P-302. Also published as *Air War and Emotional Stress*, McGraw-Hill Book Company, Inc., New York, 1951. \$5.00.
- R-216 (ATI 126081) (out of print). Theory and applications of games of strategy.** Melvin Dresher. 12-1-51. Unclassified.
An elementary mathematical exposition of games of strategy with some applications of the theory to military problems. The concepts and results developed by John von Neumann are described, and extensions of the theory and its applications undertaken at RAND are presented. A knowledge of calculus and algebra is sufficient for understanding this report. 144 pp. Illus. See revision R-360.
- **R-222 (out of print). Weight-strength analysis of aircraft structures.** F. R. Shanley. 7-1-52. Unclassified.
An attempt to determine the lightest practical arrangement of material that will transmit required loads through specified distances. The development of structural-weight formulas is discussed for

various types of wing and fuselage structures. These methods are extended to include the effects of elevated temperatures and time. 394 pp. Illus. First edition published by McGraw-Hill Book Company, Inc., New York, 1952 (out of print). \$8.50. Second edition published by Dover Publications, Inc., New York, 1960. \$2.45.

- △● **R-223 (AD 19992) (out of print). Soviet military doctrine.** R. L. Garthoff. 5-1-53. Unclassified.

An attempt to (1) construct the pattern of Soviet military doctrine, (2) offer certain interpretations of its basis, and (3) specify those tenets not recognized by the Soviets as part of their formal doctrine, but which actually play a substantial role in it. 587 pp. Illus. See P-521. Published as *Soviet Military Doctrine*, The Free Press, Glencoe, Illinois, 1953. \$7.50.

- **R-224 (AD 713) (out of print). Economic replacement policy.** A. A. Alchian. 4-12-52. Unclassified.

A practical guide for equipment replacement based on the comparison of present-value costs. This study, applicable to a wide variety of replacement situations, includes a description of the method, examples of its use, and tables of computing factors to facilitate its application. 129 pp. Illus. See abbreviated version RM-2153.

- R-228 (out of print*). Introduction to the theory of games.** J. C. C. McKinsey. 7-1-52. Unclassified.

A textbook in the theory of games which discusses the mathematical theory of situations involving conflict among rational agents. The problem considered is: How should each agent maximize his expectation of gain. This report not only applies to such games of strategy as chess, bridge, and poker, but also to such studies as economics, statistics, and the theory of military strategy. 371 pp. Illus. Also published as *Introduction to the Theory of Games*, McGraw-Hill Book Company, Inc., New York, 1952. \$6.50.

- R-233 (out of print). Notes on multigroup techniques for the investigation of neutron diffusion.** George Safonov. 1-1-52. Unclassified.

A presentation of multigroup equations to analyze neutron diffusion in general and to study reactor criticality in particular. These equations are constructed from the Boltzmann equation used in conjunction with the diffusion approximation and an integral relating neutron flux and current. 31 pp. Illus.

- **R-234 (AD 93608). Offset circle probabilities.** Numerical Analysis Department, Mathematics Division. 3-14-52. Unclassified.

A table which gives the probability that a bomb aimed at one target structure or area will hit (or miss) a nearby structure or area. 18 pp. Illus. See companion piece RM-339.

- R-239 (out of print*). A study of bolshevism.** N. C. Leites. 5-1-53. Unclassified.

An examination of the entire verbal and written record of bolshevism in an attempt to codify bolshevik political strategy. This report serves as an aid in interpreting and predicting Soviet political behavior. 639 pp. See R-206 (out of print). Also published as *A Study of Bolshevism*, The Free Press, Glencoe, Illinois, 1953. \$6.50.

- **R-240 (AD 8200). Gamma-ray transmission through finite slabs.** G. H. Peebles. 12-1-52. Unclassified.

A summary report which provides useful data for solving gamma-ray transmission problems. 203 pp. Illus. See also P-368, *Attenuation of Gamma Rays*, Parts I and II.

- **R-245 (AD 74903) (out of print). An introduction to the theory of dynamic programming.** R. E. Bellman. June, 1953. Unclassified.

A discussion of dynamic programming, defined as a mathematical theory devoted to the study of multistage processes. These processes are composed of sequences of operations in which the outcome of those preceding may be used to guide the course of future ones. Operations of both deterministic and stochastic types are considered. 99 pp. Illus. See also R-295.

△● **R-249 (out of print). Capabilities and operating costs of possible future transport airplanes.** T. V. Jones and the Aircraft Design Section. 7-16-53. Unclassified.

An attempt to determine the capabilities and operating costs of potential transport aircraft. This report (1) illustrates how aircraft should be compared in performing a logistics job by providing a sample operational analysis of transport airplane use and (2) discusses the design and analysis of many possible future transport aircraft which could be operational in 8 to 10 years if the necessary engine and airframe development were carried on from the present time. 195 pp. Illus.

R-249 (supplement) (AD 85413). Capabilities and operating costs of possible future transport airplanes: turbofan engine supplement. Design Section, Aircraft Division. 9-15-54. Unclassified.

Data on transport airplanes powered by turbofan and "bypass turbojet" powerplants. The study compares turbofan-powered transports with turbojet- and turboprop-powered aircraft, states the assumptions considered in this analysis, and discusses the characteristics of the turbofan-powered transport. 82 pp. Illus.

● **R-251-AEC (amended). Worldwide effects of atomic weapons: Project SUNSHINE.** Physics Department. 8-6-53. Unclassified.

A presentation of a 1953 estimate of the fallout problem. The report discusses the various aspects of long-range contamination due to the detonation of large numbers of nuclear devices. An improved methodology for assessing the human hazard is developed, and an extensive experimental program is proposed. 107 pp. Illus.

R-253 (AD 90415). Soviet national income and product, 1940 through 1948. A. Bergson and H. Heymann, Jr. June 1953. Unclassified.

Part of a broader examination to determine the war potential and vulnerabilities of the USSR economy. Data are compiled for 1940-48 on (1) national economic accounts, i.e., sector and global accounts of incomes and their disposition, and (2) the adjusted factor cost, i.e., unit cost at factor price corresponding on the average to relative factor productivities in different economic sectors. 261 pp. Tables. See revised data in RM-2544. See also R-255 and R-367-PR. Published by the Columbia University Press, New York, 1954. \$5.00.

● **R-254 (AD 116589). Efficiency and economy in government through new budgeting and accounting procedures.** David Novick. 2-1-54. Unclassified.

A proposed method of budgeting and accounting for the federal government, with special reference to the military departments and to the Air Force in particular. The budget considered is based on missions performed by organizational units operating specified types of primary equipment. This new concept permits the easy evaluation of differences in cost, gives operators better control over the relationship between resources and the mission assigned to them, and permits accumulation of information in meaningful terms at every level of activity up to and including policy-making. 133 pp. Illus.

R-255 (AD 90414). Soviet national income and product in 1928. Oleg Hoeffding. January 1954. Unclassified.

Part of a broader investigation to determine the war potential and vulnerabilities of the USSR economy. This report estimates the national income and product of the Soviet Union in 1928. 160 pp. Tables. See revised data in RM-2544. See also R-253 and R-367-PR. Published by the Columbia University Press, New York, 1954. \$3.75.

● **R-256 (AD 68786) (out of print). A survey of the mathematical theory of time-lag, retarded control, and hereditary processes.** R. E. Bellman and J. M. Danskin, Jr. 3-1-54. Unclassified.

A summary of the mathematical techniques required to analyze physical phenomena involving time lags, retarded control, or hereditary effects. Applications of these methods are significant in various fields (e.g., guided missile design, economics, psychology, medicine, and biology) and in theories of elasticity, magnetism, and fission processes. 113 pp.

R-257 (AD 90417). Labor productivity in Soviet and American industry. Walter Galenson. January 1954. Unclassified.

A report, which traces the development of labor productivity in numerous Soviet industries since 1928, compares productivity in these industries with U.S. counterparts, and discusses some generalizations on comparative labor productivity in Soviet and American industry. 287 pp. Tables. Published by the Columbia University Press, New York, 1955. \$5.50.

- **R-258-RC. A brief survey of the technology and economics of water supply.** J. C. DeHaven, L. A. Gore, and J. Hirshleifer. October 1953. Second edition, 1955. Unclassified.

A RAND Corporation study which delineates the problems of water supply and indicates the more important areas of research in this field. The hydrologic cycle, together with theoretical aspects, is examined in order to provide a background for assessing the total natural water available to the U.S. and its distribution by source. In addition, the present and future costs of producing fresh water from saline by known technically feasible processes are estimated. 62 pp. Illus.

R-259. Survey of reacting mixtures employing U^{235} , Pu^{239} , and U^{233} for fuel and H_2O , D_2O , C, Be, and BeO for moderator. George Safonov. 1-8-54. Unclassified.

The results of an investigation of the trends and relative value of parameters associated with a broad spectrum of reacting mixtures. An attempt to achieve a closer agreement between theory and experiment is made by computing the size, fuel requirement, and certain features of the neutron spectra on RAND CPC (card-programmed calculator) machines, instead of by hand. 13 pp. Illus.

R-264 (AD 90416) (out of print*). Approximations for digital computers. Cecil Hastings, Jr. Assisted by J. T. Hayward and J. P. Wong, Jr. November 1954. Unclassified.

An investigation concerning best approximation in the sense of Chebyshev as applied to the problem of making univariate functional data available to the high-speed digital computing machine. Part I serves as an introduction to the collection of approximations presented in Part II. 207 pp. Illus. Published by the Princeton University Press, Princeton, New Jersey, 1955. \$4.00.

- **R-271 (AD 90491). Dynamic programming of continuous processes.** R. E. Bellman. July 1954. Unclassified.

A survey of the mathematical techniques of the dynamic programming theory as applied to some continuous decision processes of economic, industrial, and military import. In particular, this report discusses (1) a stochastic decision process of continuous type and alternate formulations of the associated mathematical problems, (2) a general class of multistage allocation processes, (3) the functional-equation approach of the dynamic programming theory in connection with the calculus of variations, and (4) some representative problems in the field of scheduling. 159 pp. Illus.

- **R-273 (AD 80305). Heat-transfer aspects of the atmospheric re-entry of long-range ballistic missiles.** Carl Gazley, Jr. First printing 8-1-54. Second printing April 1959. Unclassified.

A study of the aerodynamic heating problems encountered by long-range ballistic missiles during re-entry into the atmosphere. This report analyzes the effects of (1) various design parameters on the heating rate and total heating during re-entry and (2) heating considerations on the re-entry-stage design. In addition, possible cooling systems and their characteristics are discussed. 110 pp. Illus.

- **R-277 (AD 90420). Equations of state on the Thomas-Fermi statistical model.** Richard Latter. 4-1-54. Unclassified.

A presentation of solutions sufficiently extensive to determine the thermodynamic properties of all elements over an exceedingly wide range of temperatures and densities by means of an IBM 701 Defense Calculator. Various analytic properties of the Thomas-Fermi equations are examined, and certain approximate analytic solutions are derived for limiting cases. 56 pp. Illus.

R-279. Critical mixtures of uranium and 500°F light water. George Safonov. 1-8-55.
Unclassified.

A survey of parameters which are determined by neutronics for a broad spectrum of reactor types. Specifically, those mixtures of U^{235} , U^{238} , and 500°F light water which may sustain a chain reaction in bare convex geometry are considered. 38 pp. Illus.

R-285 (AD 112412). International communication and political opinion: a guide to the literature. B. L. Smith and C. M. Smith. Prepared by the Bureau of Social Science Research, The American University. January 1956. Unclassified.

A continuation of *Propaganda, Communication and Public Opinion*, by Bruce L. Smith, Harold D. Lasswell, and Ralph D. Casey (Princeton University Press, 1946) which cites and describes materials published up to mid-1943. The present bibliography covers the period between mid-1943 and mid-1955 systematically, and includes some materials published as late as the spring of 1956. 336 pp. Also published by Princeton University Press, Princeton, N.J., December, 1956. \$6.00.

● **R-287 (out of print). Weapon-system cost methodology.** David Novick. 2-1-56. Unclassified.

A method for estimating the costs of existing and hypothetical weapon systems of the U.S. Air Force. The author attempts to establish approximate resource and cost requirements and to provide a basis for evaluating alternative systems in terms of (1) the cost of a given capability and (2) the capability obtainable for a fixed cost. This report may be useful in military planning, programming, and budgeting activities. 57 pp. Illus.

● **R-291 (AD 105540). Cost-quantity relationships in the airframe industry.** Harold Asher. 7-1-56. Unclassified.

A discussion of the progress or learning curve used to estimate the cost of aircraft equipment and other types of products for both military and civilian consumption, as well as the cost of airframes. This report attempts to indicate whether the conventional progress curve, which is linear on logarithmic grids, is an accurate description of the relationship between unit cost and cumulative output. 199 pp. Illus.

● **R-292 (AD 107426). Characteristics of demand for aircraft spare parts.** B. B. Brown. July 1956. Unclassified.

The results of various RAND studies on the demand for aircraft spare parts. Ways are devised by which the demand pattern can be estimated for the insurance-type items, and certain stockage and procurement procedures are suggested in the case of unpredictable demands. This report may aid in specifying the over-all design of the logistics system and the policies for distribution and requirements that the system should follow. 50 pp. Illus.

R-295 (AD 144264) (out of print*). Dynamic programming. R. E. Bellman. 9-1-56. Unclassified.

An introduction to the mathematical theory of multistage decision processes. The study involves a certain conceptual framework which furnishes a new and versatile mathematical tool for the treatment of many novel and interesting problems in dynamic programming and in various parts of classical analysis. This report may be of aid to graduate students in mathematics, economics, and engineering, as well as to research workers in operations analysis and systems analysis. 367 pp. Illus. See R-245 (out of print). Published by Princeton University Press, Princeton, New Jersey, 1957. \$6.75.

R-298 (AD 123559). German rearmament and atomic war. Hans Speier. 2-15-57. Unclassified.

A discussion of the views of German military and political leaders on current international affairs, on the prospects and shape of war in the future, and on German rearmament. The study covers the period from 1952 to 1957. Part I presents primarily opinions of former German generals and military officers. Part II reviews the main arguments for and against Chancellor Adenauer's military policy advanced by deputies of the *Bundesrat* and compares them with the less publicized opinions of German military leaders. 283 pp. Published by Row, Peterson & Co., Evanston, Illinois. 1957. \$5.00.

R-302 (AD 158074). The Berlin blockade: a study in cold war politics. W. P. Davison. 9-1-57. Unclassified.

A study of some aspects of the Berlin crisis of 1948 to 1949, including Soviet diplomacy, communist techniques of propaganda and terror, the process of Allied decisionmaking, and the strengths and weaknesses of the Western coalition. The author summarizes the history of Germany and Berlin from 1945 to 1948, discusses the dramatic events in Berlin during the time it was under siege, and analyzes the communist defeat in West Germany, the anatomy of Berlin morale, and the role of public opinion in the crisis. This account is based on interviews with German and Allied leaders and observers who had personal knowledge of the blockade, on the accounts of life in the besieged city provided by several hundred Berliners, and on official documents from Berlin, Bonn, Moscow, and Washington. 439 pp. Illus. Published by Princeton University Press, Princeton, New Jersey, 1958. \$7.50.

R-308 (AD 157617) (out of print*). Strategic surrender: the politics of victory and defeat. Paul Kecskemeti. 7-26-57. Unclassified.

A study dealing with strategic surrender as a problem in political theory and, in particular, with the surrender policy of the Western Allies in World War II. The context in which this theoretical problem arises is that of the transition from war to peace when one side is completely victorious. Four major cases of strategic surrender are examined to show the interaction of strategic constraints and of political desires and beliefs in shaping the concluding stage of hostilities. It is concluded that the "unconditional surrender" formula of World War II was ill conceived, that no surrender, not even Germany's, was entirely unconditional, and that in some cases the Allies actually harmed themselves by pursuing that unattainable goal. 229 pp. Published by Stanford University Press, Stanford, California, 1958. \$5.00.

• **R-309 (AD 150662). Close-in fallout.** 9-30-57. Unclassified.

A summary of the physical processes of radioactive fallout from nuclear weapons and of the methods of computing fallout patterns. "Close-in" fallout is emphasized, or fallout occurring within a few hundred miles of the weapon burst point. The report discusses the physical processes of fallout (what happens to the radioactive fission products from the time just after the weapon explodes until the time fallout is on the ground), computing fallout patterns (the various methods used to predict fallout and their capabilities and limitations), and continuing RAND research on fallout (the current and future directions of research at RAND into the processes, prediction, and operational implications of fallout). 42 pp. Illus.

R-311 (AD 150689) (out of print*). Behind the sputniks: a survey of Soviet space science. F. J. Krierger. 11-3-57. Unclassified.

An investigation of recent Russian research and ideas on such matters as artificial satellites, flight to the moon, interplanetary communications, biological aspects of space travel, atomic airplanes, trips to the planets, worldwide television broadcasting from space stations, intercontinental rocketry, and the technical problems of cosmic flight. This report delineates the history of the development of astronautics in Russia from the turn of the century up to the launching of the first artificial earth satellite. It shows how the Soviets, in their struggle for world domination, are applying their sledge-hammer technique not only to terrestrial affairs but also to the conquest of cosmic space. 386 pp. Illus. Supersedes RM-1760 and RM-1922. Published by the Public Affairs Press, Washington, D.C., 1958. \$6.00.

• **R-313 (AD 158407). Some aspects of the mathematical theory of control processes.**

R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 1-16-58. Unclassified.

A presentation of (1) various representative mathematical problems that arise in the modern theory of the control of economic, industrial, engineering, and military systems, and (2) the types of mathematical theories and techniques that can be used to treat these problems. These problems are variational in the sense that the aim is to maximize or minimize some function which is being used as a criterion of the performance of the system under consideration. What distinguishes these problems from those encountered in the classical calculus of variations is the presence of constraints of physical origin, the consideration of random effects, or, alternatively, the introduction of the theory of games, and finally, the emphasis on computational solution. An attempt is made to

indicate the new types of mathematical problems that have arisen from the more realistic description of old problems and from the pressure of new problems, and to illustrate the applicability of a wide variety of mathematical tools to their solution. 263 pp. Illus.

- **R-316. Externally moderated reactors.** George Safonov. July 1957. Unclassified.

A presentation of a reactor-statics theory for a group of thermal systems having spherical symmetry. These are characterized by two basic regions: a nonmoderating interior region with fuel is surrounded by a moderating exterior. Two classes of reactor interior regions are considered. One class, which comprises the interiors of "cavity reactors," has low-density cores that cannot scatter thermal neutrons. Interiors of the second class have high scattering probabilities for thermal neutrons. The theory is applied to criticality surveys of cavity reactors, to special features of liquid metal fueled reactor systems, to studies of flux profiles, and to preliminary considerations of some possible applications of the externally moderated concept. 41 pp. Illus.

- **R-318 (AD 219661). A time series analysis of interindustry demands.** K. J. Arrow, M. Hoffenberg, H. Markowitz, and R. W. Shephard. November 1958. Unclassified.

A study of the demand by different industries for each other's products to analyze the effect of major changes in the quantity of resources available to a nation or in the demands made on a nation's resources. The time period considered is 1929 to 1950. The point of departure is the classical fixed-coefficients model, in the sense that the variations of observed industry outputs have been examined from those which would have prevailed had production coefficients been constant over time. An attempt has been made to relate these variations to other economic variables and to construct a model that would relate changes in interindustry demands to a few major variables. 298 pp. Illus. Published by the North-Holland Publishing Company, Amsterdam, 1959. \$7.25.

- **R-322-RC. Report on a study of non-military defense.** 7-1-58. Unclassified.

A report on non-military defense which considers such problems as population shelters, long-term fallout, economic recuperation, possible non-military defense programs, and interactions with other aspects of national defense. The study was initiated in the belief that non-military defense measures, if they could be made effective in protecting the civilian population, economy, and institutions of the United States, might make two significant contributions to the national defense. First, they might alleviate the catastrophe of a nuclear attack and, if military victory were attained, provide a reasonable chance that the United States as a nation could survive. Second, they might increase U.S. freedom of action in conducting peacetime foreign policy and in implementing a broad deterrence strategy. 53 pp. Tables.

- **R-323 (AD 156042). Laboratory evaluation of supply and procurement policies.** R. M. Rauner. July 1958. Unclassified.

A description of Laboratory Problem I (LP-I), the first large-scale logistics simulation performed in RAND's Logistics Systems Laboratory to evaluate a set of proposed supply policies and procedures. These policies and procedures were used in a simulated Air Force environment and compared with another set of policies based on Air Force logistics practices that were more or less current in mid-1956. Two wars were simulated in the experiment to test the ability of each system to operate without central supply or maintenance support under the stress of enemy attacks. In general, the simulation of logistics activity in the Laboratory proved useful and successful as an adjunct to logistics research. 108 pp. Illus.

- **R-326 (AD 214634) (out of print*). War and the Soviet Union: nuclear weapons and the revolution in Soviet military and political thinking.** H. S. Dincerstein. 8-11-58. Unclassified.

A description of the revolution in Soviet ideas about war since Stalin's death. These new ideas have appeared primarily as a result of a careful reassessment of the importance of nuclear weapons and of the improvements in the means of delivering them. The report discusses (1) the Soviet controversy on military theory that occurred between the fall of 1953 and the spring of 1955; (2) whether and to what extent the Soviet leaders rely on the military balance to deter their presumptive enemy, the United States; (3) a few cases in which the domestic dispute over military policy played an important role in Soviet politics at the highest level; (4) Soviet views on pre-emptive attack and its relationship to preventive war; and (5) the roles assigned to the various

military arms in the execution of Soviet strategy. At present, the guiding Soviet principle of war is readiness to fight any kind of war in the most effective way. The basis of their doctrine is that the most awful consequences of war can be reduced by the creation and thorough training of a differentiated force ready for every contingency. The Soviet leaders believe that in some circumstances it may be desirable to strike an initial nuclear blow, and they mean to have a military establishment suited to that end. 276 pp. Published under the same title by Frederick A. Praeger, Inc., New York, 1959. \$5.50.

R-333 (AD 226128). Military research and development policies. B. H. Klein, W. H. Meckling, and E. G. Mesthene. 12-4-58. Unclassified.

The findings of a study on military research and development. An attempt was made to discover what kinds of policies are most effective in providing the military services with new weapons. Based on an examination of past programs, this study investigated the development histories of many of the postwar fighters and bombers, most of the postwar engines, and all of the postwar bombing-navigation systems. Most of the cases considered were taken from the history of research and development in the Air Force, although the findings are relevant to all military R&D. In particular, the general nature of military R&D is discussed, the shortcomings of some present development policies are indicated, a more fruitful approach to weapon-system development is suggested, and the question of providing technological building blocks for future weapons is considered. 32 pp.

R-335 (AD 226129). Strategy in the missile age. Bernard Brodie. 1-15-59. Unclassified.

A review of the development of modern military strategy to World War II, including the great historical strategic ideas developed from Clausewitz to Douhet. The report considers problems of the strategic retaliatory force, of civil defense, of limited war, of counterforce or pre-emptive strategies, of city-busting, and of missile bases in Europe. The author analyzes the requirements of strength for the 1960's and the military posture necessary to prevent war. The problem of the cost of preparedness in relation to the requirements of the national economy is also discussed. 438 pp. Published by Princeton University Press, Princeton, N.J., 1959. \$6.50.

• **R-336-RC. Research and the ulcer problem.** I. S. Blumenthal. March 1959. Rev. June 1959. Unclassified.

A report on one particular group of chronic diseases: the ulcerative disorders of the gastro-intestinal tract. The group includes peptic ulcer and ulcerative colitis. An attempt is made to answer questions concerning the social magnitude of the problem, the adequacy of current medical solutions, and the scope of certain research efforts in the ulcerative-disorder field. Money devoted to research in this area has been less than 1 per cent of the estimated economic loss to the nation because of these diseases. It is hoped that this analysis may be of interest to governmental agencies and private foundations supporting research in the biomedical field. 90 pp. Illus.

• **R-339. Aerodynamics of the upper atmosphere.** D. J. Masson (comp.). June 1959. Unclassified.

A compilation of papers submitted to the RAND-sponsored Symposium on Aerodynamics of the Upper Atmosphere. The Symposium was held June 8-10, 1959, to discuss problems of rarified gasdynamics as they pertain to the forces on satellite-type bodies. The report discusses the interaction of a high-velocity body with the upper atmosphere and the implications in interpreting satellite orbit data. In addition, useful reference material covering the gasdynamic characteristics of upper-atmosphere flight is presented. 478 pp. Illus.

• **R-341 (AD 231659 and AD 231660) (out of print). Proceedings of the Second Protective Construction Symposium (deep underground construction)—vols. I and II.** J. J. O'Sullivan (comp.). March 1959. Unclassified.

A collection of 45 papers submitted to the RAND-sponsored Second Protective Construction Symposium. This Symposium was held March 24-26, 1959, for military officers and civilian architects and engineers interested in problems of protecting military installations located deep underground or under mountains. The report discusses many diverse aspects of the current technology of deep underground shelters and emphasizes primarily the design and construction of underground facilities to resist nuclear-weapons effects. 1002 pp. Illus. Published under the title, *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, by The Macmillan Company, New York, 1961. \$25.00.

R-346 (AD 243098). The economics of defense in the nuclear age. C. J. Hitch and R. N. McKean. March 1960. Unclassified.

A discussion of the contribution of economic analysis to preferred military policy planning in the nuclear age in terms of the most efficient allocation of resources available for defense. Economic problems are considered at each of three levels: (1) the quantity of national resources available, now and in the future, (2) the proportion of these resources allocated to national security purposes, and (3) the efficiency with which the resources so allocated are used by the defense departments. The alternative policies existing at each level from which officials must choose are also considered. 442 pp. Illus. Published under the same title by Harvard University Press, Cambridge, Mass., 1960. \$9.50.

- **R-348 (AD 230099).** A method of concealing underground nuclear explosions. A. L. Latter, R. E. LeVier, E. A. Martinelli, and W. G. McMillan. 3-30-59. Unclassified.

A report that shows, theoretically, that nuclear explosions can be effectively hidden in large underground cavities. An estimate of the effectiveness of the method indicates that a yield of more than 300 KT could be made to look seismically like a yield of 1 KT. Experiments with both chemical and nuclear explosions are needed to test the theory. The possibility of concealing nuclear explosions is of vital importance in connection with the Geneva Conference on test suspension. 20 pp. Published in the *Journal of Geophysical Research*, March 1961.

R-350 (AD 254190). Adaptive control processes: a guided tour. R. E. Bellman. January 1961. Unclassified.

A survey of the modern theory of control processes and applications treated in a uniform fashion by means of the theory of dynamic programming. The report discusses the classical concept of a dynamical system as a sequence of transformations over time and gives applications of the modern theory of multistage decision processes to the calculus of variations and trajectory problems. These problems are considered from the initial step of formulation in analytic terms to the end step of computational solution by digital computers. The foundations of probability theory are examined, together with applications of dynamic programming to stochastic (i.e., random) control processes. Adaptive control processes are also treated in which learning and information-seeking are integral parts of the problem. 271 pp. Illus. Published by Princeton University Press, Princeton, New Jersey, 1961. \$6.50.

- **R-351 (AD 233753).** The RAND Symposium on Mathematical Programming: linear programming and recent extensions—proceedings of a conference, March 16–20, 1959. P. S. Wolfe (ed.). 1959. Unclassified.

The proceedings of the Symposium on Mathematical Programming, held at Santa Monica, California, March 16–20, 1959, and sponsored by RAND. The Symposium emphasized extensions of linear programming into areas of nonlinear programming, integer programming, programming under uncertainty, network theory, and special multistage dynamic structures. Each of these areas has seen important breakthroughs in the last two years, heralding rapid development in the application of these mathematical tools to practical problems. The proceedings consist of summaries of fifty-three papers. 142 pp. Illus.

- **R-353 (AD 236439).** On the epistemology of the inexact sciences. Olaf Helmer and N. H. Rescher. February 1960. Unclassified.

A new epistemological approach to the inexact sciences, which include applied physical sciences, such as engineering and medicine, as well as most of the social sciences. The purpose of all science is to explain past events and to predict future ones in an objective manner. While explanation and prediction have the same logical structure in the exact sciences, this is not so in the inexact sciences. This fact leads to the development of specifically predictive instrumentalities in these fields and to various methodological innovations. Among these are the systematic employment of expert judgment and the use of pseudoexperimentation, involving simulation processes, and in particular, operational gaming. 45 pp.

R-356 (AD 248256). China crosses the Yalu: the decision to enter the Korean War.

A. S. Whiting, November 1960. Unclassified.

An analysis of the factors contributing to Peking's decision to intervene in the Korean War, a decision that resulted in the clandestine crossing of the Yalu River by 300,000 Chinese Communist "volunteers" in the weeks before November 26, 1950. The author believes that Chinese Communist behavior was "rationally motivated." He finds that the Chinese neither participated in planning the initial North Korean aggression nor intervened later as the result of Russian pressure. This report is particularly relevant to problems of deterrence, communication, and military movement in limited war. 228 pp. Illus. Published by The Macmillan Company, New York, 1960. \$7.50.

- **R-358 (AD 255551). Automatic checkout equipment: employment and design considerations.** S. I. Firstman, M. Kamins, and B. J. Voosen. September 1960. Unclassified.

A report on some design and test principles for automatic test and checkout equipment. Techniques for programming and control are studied, first by comparing some of the relevant differences between the two principal types of automatic programmers (internally and externally programmed). Contrasting methods of testing are then covered in a comparison of static and dynamic testing. Alternative methods of measurement are presented in a discussion of the analog and digital approaches. Two ways of displaying results and of making decisions based on them are examined through a comparison of qualitative and quantitative methods. Finally, the study deals with the question of whether the testing function should be performed by an integral portion of the weapon system under test or by an auxiliary device. 84 pp. Illus.

- **R-360 (AD 257899). Games of strategy: theory and applications.** Melvin Dresher. May 1961. Unclassified.

A report on improved methods of analyzing situations of conflict. The study develops the mathematical theory of games of strategy, or the theory of conflict between two opposing sides. Examples of its applications to military problems are provided. These problems concern decisions on the allocation of forces in space and/or time in strategic air war, tactical air war, and target prediction. 192 pp. Illus. A revised and up-dated version of R-216, *Theory and Applications of Games of Strategy*, published in 1951. Published by Prentice-Hall, Inc., Englewood Cliffs, N. J., July 1961. \$9.00.

- **R-362-RC. International political implications of activities in outer space: a report of a conference, October 22-23, 1959.** J. M. Goldsen. 5-5-60. Unclassified.

A report of the Conference on International Political Implications of Activities in Outer Space, held on October 22 and 23, 1959, at Washington, D.C. Part I presents a transcript of the conference covering the technological environment of outer space and its prospects, the political and military background and short-run outlook, some problems of the near future and possible approaches, and the future from 1984 and beyond. Part II consists of conference papers dealing with public opinion and the development of space technology, the international implications of outer space activities, outer space and international politics, and the natural history of man's emergence into space. 216 pp. Illus.

- **R-363 (AD 249504). An application of superconductivity to inertial navigation.** W. H. Culver and M. H. Davis. 1-7-57. Unclassified.

A proposal of a new type of gyro that may be suitable for use in inertial guidance systems. The basic element of the system is a spinning, superconducting sphere, maintained at a temperature of a few degrees Kelvin, that is supported by magnetic fields. Such a device may not be susceptible to the drift problems of conventional gyros. 12 pp. Illus. Also published as RM-1852.

- **R-365 (AD 252699). Inquiry into the feasibility of weather reconnaissance from a satellite vehicle.** S. M. Greenfield and W. W. Kellogg. August 1960. Unclassified.

A discussion of the problem of obtaining an over-all picture of the wide-scale weather situation. An attempt is made to present methods of attack on this problem, to show what may be actually seen from high-altitude photographs (primarily a discussion on necessary resolution and area coverages), to discuss what may be determined from these photographs (both directly and indirectly), and to give some of the results. Although this analysis is based on data obtained from vertically

fired rockets, suggestions are made on possible methods of forming a synoptic picture from satellite-missile photographs. 49 pp. Illus.

R-367-PR (AD 268170). The real national income of Soviet Russia since 1928. Abram Bergson, October 1961. Unclassified.

An assessment of the strength of the Soviet economy as a whole and in its various sectors in an attempt to estimate the strength of those elements that contribute to military capability. The method used compiles income and outlay data for the USSR in accord with the principles of national income accounting familiar in the United States and other Western countries. The period covered extends from 1928, the beginning of the first Five Year Plan, to 1955 and, in less detail, to 1958. This makes possible long-term comparisons of the economic growth rates between the United States and the Soviet Union, and provides a base from which improved estimates of future developments and their strategic implications can be made. 488 pp. Illus. See also R-253 and R-255. Published by the Harvard University Press, Cambridge, Massachusetts, 1961. \$8.75.

- **R-368 (AD 252114).** Geomagnetic field lines in space. E. H. Vestine and W. L. Sibley. December 1960. Unclassified.

A discussion of the geomagnetic field lines in space, calculated on the basis of potential theory. The locations of various lines of geomagnetic force and the magnitude of the field are estimated out to 10 earth radii and more. The auroral zones, northern and southern, appear to be interlinked by lines of geomagnetic force. Integral invariants of charged-particle motion along the lines of force are estimated and, with the total magnetic field, define important particulars in connection with the particle distribution in the Van Allen radiation belts. 115 pp. Illus.

- **R-382 (AD 266147).** Influence of resource and policy changes on aircraft capabilities. C. F. Bell. August 1961. Unclassified.

An illustration of the extreme sensitivity of manned-aircraft weapon-system capabilities to operational and support policies and to resource allocations at base level. This report examines the effects on operational capability of changes in the flying program, ground-alert requirements, workshift and scheduled maintenance policies, number of aircraft in the organization, manning tables, and management responsiveness in the use of available resources. The relative effects of the changes are also shown. The author suggests techniques for determining the best quantities of resources to meet operational objectives at minimum cost, or for maximizing operational capability with existing resources, at several points in the life-cycle of the weapon system. Substantial payoffs, both short- and long-range, are shown to be possible through greater management responsiveness in the use of resources, multi-shift operation, and establishment of different manpower requirements during the phasing-in and phasing-out periods. 56 pp. Illus.

- **R-389-PR (AD 267299).** Distribution of the intensity and polarization of the diffusely reflected light over a planetary disk. Z. Sekera and W. Viezee. November 1961. Unclassified.

An attempt to provide space scientists with improved methods for interpreting photometric observations of sunlit planetary atmospheres as seen from the earth or a space-probe platform. In considering spherical rather than plane-parallel atmospheric geometries, and multiple rather than single scattering of impinging light, the study goes beyond previous investigations of this phenomenon. The results are presented graphically as "maps" and cross-sectional diagrams of radiation intensity and polarization distribution over the planetary disk for a variety of phase angles, optical depths, and surface reflectivities. 50 pp. Illus.

- **R-393-PR (AD 271947).** Light scattering on partially absorbing homogeneous spheres of finite size. D. Deirmendjian and R. J. Clasen. February 1962. Unclassified.

A product related to RAND studies of the characteristics of the atmospheres of the earth and neighboring planets, as inferred from the intensity and polarization of the sunlight they transmit and reflect. The quality of the light is determined by the scattering and absorption properties of particles suspended in the atmosphere. Although an exact theory for the absorption, scattering, and polarization of light illuminating a translucent or opaque sphere has been known for some time, the difficulty of the computations has inhibited any broad attack on the problem except by the use of simplifying approximations. This report describes the problem for computer solution and presents results for an unprecedented range of parameters. 51 pp. Illus.

RAND MEMORANDA

- **RM-4. Thermodynamic properties of metals.** L. W. Alvarez. 2-18-47. Unclassified. Tabulations of the thermodynamic properties of tantalum, molybdenum, tungsten, their oxides and nitrides, and some gaseous fluorine compounds. 9 pp.

- **RM-5 (ATI 174370). Randomness.** Olaf Helmer. 3-24-47. Unclassified. A study of randomness: (1) a definition, (2) spot checks on the randomness of a digit machine, and (3) methods for testing randomness. 2 pp.

- **RM-6. Combat between heterogeneous forces.** Olaf Helmer. 5-5-47. Unclassified. A generalization of the Lanchester theory of combat for the case of heterogeneous forces. Several examples are presented. 8 pp. Illus. See RM-12 and RM-13.

RM-10 (ATI 181063). An experiment in estimation. Olaf Helmer. 7-21-47. Unclassified.

A proposed experiment to appraise the predicting reliability of available personnel. Two supplementary experiments are suggested: one to study the effect of group size; the second, the effect of additional information. 2 pp.

RM-12 (ATI 210361). A note on the Lanchester equations. T. E. Oberbeck. 6-19-47. Unclassified.

A supplement to Problem (i) on page 7 of RM-6, *Combat between Heterogeneous Forces*. 2 pp.

RM-13 (ATI 210362). A second note on the Lanchester equations. T. E. Oberbeck. 6-24-47. Unclassified.

A supplement to RM-6, *Combat between Heterogeneous Forces*, and RM-12, *A Note on the Lanchester Equations*. 8 pp.

RM-15. The location of the maximum of a function of two independent variables when the dependent and independent variables are measured without error. T. E. Oberbeck and P. Armer. 8-4-47. Unclassified.

A study of several attempts to impress the method of steepest ascent (gradient) on the tentacle technique for locating the maximum of the function of two variables. 19 pp. Illus.

- **RM-16. Maximizing $z = z(x, y)$ when z is known exactly only for certain values of one or both independent variables.** T. E. Oberbeck. 8-13-47. Unclassified.

A discussion of a method which maximizes $z = z(x, y)$ when values of z can be determined only for certain values of one or of both independent variables. 8 pp. Illus.

RM-18. Medical and biological aspects of nuclear energy. A. H. Dowdy, M.D. 8-13-47. Unclassified.

A lecture on the biological effects of penetrating radiation (X-rays, gamma rays, and neutrons) on a variety of laboratory animals. The variation in dosages, lethal doses, and effects on the different types of body cells are discussed. 37 pp. Illus.

RM-24. R-7.2 maximization of a function $\varphi(X, Y)$. C. Hastings, Jr. 12-31-47. Unclassified.

A procedure, involving the randomization of input values, for locating the maximum of a function of many variables. 5 pp. Illus.

RM-28. Active defense of the United States against air attack. Staff. 2-5-48. Unclassified.

An attempt to state the problem of active defense against air attack. The basic hypotheses and conclusions relating to the study are also presented. 10 pp.

RM-31. Ville's example of a game without a strategic saddle-point. M. Dresher and J. C. C. McKinsey. 2-23-48. Unclassified.

A demonstration of the validity of Jean Ville's qualification of the von Neumann theorem on strategic saddle-points. 3 pp.

- **RM-32 (ATI 210364). Effects of source and shadow shield geometry on the scattering of gamma rays.** M. S. Plesset, C. Hastings, Jr., and S. T. Cohen. 2-26-48. Unclassified.

Exact calculations for two extreme cases of the geometrical effects of the size of shadow shield and source on the intensity of gamma rays scattered into a receiver. 59 pp. Illus. Also published as RAOP-40 (out of print).

- RM-33. Two theorems concerning solutions for games with continua of strategies.** M. Drescher and L. S. Shapley. 3-4-48. Unclassified.

A demonstration of some properties of the solution (strategic saddle-points) of an arbitrary continuous game. Definition of terms or standard notations for games with continua of strategies are given. 4 pp.

- RM-34 (out of print). Determination of shield thickness for attenuation of air-scattered gamma radiation.** M. S. Plesset, H. Kahn, and S. T. Cohen. 3-15-48. Unclassified.

An estimation of the shielding size and shape requirements necessary to protect personnel from a strong nearby source of gamma radiation. 30 pp. Illus.

- RM-37. The concept of military worth.** Abraham Kaplan. 5-7-48. Unclassified.

A conceptual analysis of the problem of military worth with an indication of the elements involved for the purpose of delimiting areas of empirical study by which each of these elements can be measured. 38 pp. Illus.

- **RM-38. Tests of the randomness of digits.** B. B. Brown. 5-17-48. Unclassified.

Results of four methods of examining a million digits produced by the random digit generator, to ensure the randomness of the numbers for the user of random numbers in common types of sampling inquiries. 13 pp. Illus. Also published as RAOP-44.

- RM-39 (out of print). Bremsstrahlung correction to transmission of gamma rays through thick media.** S. T. Cohen and E. H. Plesset. 5-20-48. Unclassified.

A study which determines the magnitude of Bremsstrahlung for beams of γ radiation with initial energies of 20 mc² and 10 mc² passing through a heavy element shield. 24 pp. Illus.

- RM-40. A "semi-Poisson" distribution.** H. H. Germond. 5-26-48. Unclassified.

An examination of the so-called "semi-Poisson" distribution. The distribution function occurs in certain results of the "shot effect" in an electronic circuit, and the variance equals one-half of the mean. 6 pp.

- RM-42. Some examples of games with continuous payoff functions.** Olaf Helmer. 6-4-48. Unclassified.

A presentation of some numerical examples of continuous games. 4 pp.

- **RM-43. Aerodynamics of spheres.** Herman Kahn. 6-23-48. Unclassified.

A compilation of formulas and curves which elucidate the simpler aerodynamic qualities of spheres. 22 pp. Illus.

- **RM-46. Systems of linear production function (Cowles Commission Discussion Papers, Economics, No. 215).** T. C. Koopmans. 2-10-48. Unclassified.

A progress report which examines the extent to which more elementary mathematical tools can be used. The purpose of this analysis is to demonstrate (1) the concept of optimal prices without the concept of a market, (2) the concept of a "general transformation function" expressing the convertibility of all goods through production, and (3) the concept of an aggregate production function connecting "value of product," "value of capital," and quantities of primary factors of production. 14 pp. See supplement RM-47.

- RM-47. Remarks on reduction and aggregation.** T. C. Koopmans. 7-21-48. Unclassified.

A supplement to RM-46, *Systems of Linear Production Function (Cowles Commission Discussion Papers, Economics, No. 215)*. 2 pp.

- **RM-48. An elucidation of Stone's solution for a slightly yawing supersonic cone.** G. B. W. Young. 7-20-48. Unclassified.

A physical interpretation of the mathematical analysis of Stone. Expressions for the flow characteristics in the conical field are scrutinized. 27 pp. Illus.

- **RM-49 (out of print). Elastic scattering of neutrons.** Herman Kahn. 8-3-48. Unclassified.

A preliminary study of the problem of the transmission of neutrons through plane slabs under conditions of elastic scattering and absorption. 113 pp. Illus.

- RM-50. Tables of integrals associated with the error function of a complex variable.** C. Hastings, Jr., and J. I. Marcum. 8-1-48. Unclassified.

A tabular computation of the integrals which are associated with the error function of a complex variable. 61 pp. Illus.

- RM-59. Representation by sums of separable functions.** O. A. Gross. 10-19-48. Unclassified.

A presentation of a general method which decomposes a function of two variables into a sum of separable functions. An application of the method in the approximation sense to a numerical example. 3 pp.

- **RM-66. A method for the evaluation of ramjet fuels.** R. J. Lew. 11-1-48. Unclassified.
- An equation for measuring the merit of ramjet fuels in terms of missile range. An illustrative example of its use is given. 8 pp. Illus.

- RM-67 (ATI 174611). On the concept of utility and decision-making.** R. E. Bellman. 10-26-48. Unclassified.

A critical discussion of some axioms appearing in the paper of K. Arrow on a universal social welfare function, RAOP-41. Special disagreement is made with the one-dimensionalizing of the problems of social decision. 5 pp.

- **RM-71. Tables of dynamic pressure.** R. S. Paulson. 11-23-48. Unclassified.
- Tables of dynamic pressure for a wide range of speed and altitude. 13 pp.

- **RM-74. A differential equation with random shocks.** T. E. Harris and E. W. Paxson. 12-3-48. Unclassified.

A study of conflicting forces in a model differing from the Lanchester type. A small number of massive blows is assumed to disturb the conditions described by certain differential or difference-differential equations. 7 pp.

- RM-76. Least-squares approximations by sums of separable functions.** G. W. Brown. 12-7-48. Unclassified.

An elementary proof of a method for obtaining the least-squares fit by the sum of separable functions. 3 pp.

- **RM-81. Preliminary analysis of effective polarization on gamma-ray transmission.** Herman Kahn. 12-23-48. Unclassified.

An examination of some typical two-scattering histories to show the relationship between polarization and the transmission of gamma rays. 10 pp. Illus.

- RM-83. Representation by sums of separable functions in n dimensions.** O. A. Gross. 12-27-48. Unclassified.

A method of representing a function of n variables by the sum of separable functions. 3 pp.

- RM-86. A note on the sums of powers of the roots of a polynomial.** O. A. Gross. 12-31-48. Unclassified.

A method for computing sums of powers of the roots of a polynomial. 2 pp.

RM-87 (AD 109333). Examination of some models of failure of equipment during operation. D. J. Davis and W. J. Howard. 10-26-48. Unclassified.

An examination of several factors which affect "chance" distribution of failure of physical articles. A very simplified model of mechanism and environment is established as a point of departure from which other models are introduced and compared. 27 pp. Illus.

RM-92. Forecast of production time. H. H. Germond. 1-20-49. Unclassified.

A discussion of the aim and method of forecasting the time required per operation at some future stage. 7 pp. Illus.

RM-97. Hermite polynomials of imaginary argument. H. H. Germond. 2-1-49. Unclassified.

A report on the definitions and corresponding properties of hermite polynomials which appear in the evaluation of certain integrals. 14 pp.

RM-98. Note on a functional form for polynomials. O. A. Gross. 2-1-49. Unclassified.

A tentative approach to the problem of determining a functional form for polynomials. 1 p.

- **RM-100 (AD 112382). A general problem in the calculus of variations with applications to paths of least time.** M. R. Hestenes. February 1949. Rev. 3-1-50. Unclassified.

A discussion of certain analytical problems to determine the optimum path for an airplane. 45 pp. See P-199.

- **RM-101. A hidden-target model.** L. S. Shapley. 2-14-49. Unclassified.

A description of a game between two players, which is a variant of "Button, button." One player has an object of great value which he may conceal in one of two containers. The other attempts to destroy the object by destroying the containers. 11 pp. Illus.

RM-102. Numerical methods of obtaining solutions of fixed end-point problems in the calculus of variations. M. R. Hestenes. 8-14-49. Unclassified.

A generalization of the method of Newton for functions of a single real variable x . The method presented computes arcs which satisfy the Euler equations of an integral subject to certain boundary conditions. 17 pp. Tables.

- **RM-103. On the number of preference arrangements of n objects.** O. A. Gross. 2-14-49. Unclassified.

A memorandum on the preference arrangement of several decisions into ordered groups. The adjustment within the groups is assumed to be indifferent. 4 pp.

- **RM-104 (out of print). The economic strength of the Soviet Union.** J. A. Kershaw. 5-2-49. Unclassified.

A compendium of writings analyzing the growth and status of Soviet economy relative to its past and future, and compared with other world economies. 33 pp.

- **RM-106 (AD 107270). Gas turbine cycle analysis by means of entropy changes and polytropic component efficiencies.** L. R. Woodworth. 2-15-49. Unclassified.

An attempt to clarify the use of entropy changes and polytropic or small-stage component efficiencies in gas turbine cycle analysis. Working charts are constructed for determination of the cycle output for any chosen set of component efficiency levels or for any cycle condition of top temperature or pressure ratio for any flight speed and altitude. 26 pp. Illus.

- **RM-109. Construction of group preference relations by iteration.** N. C. Dalkey. 2-21-49. Unclassified.

An examination of the possibility of constructing a group preference relation for a number of individuals by iterating an aggregation method originally defined for two individuals. 3 pp.

- **RM-111. An asymptotic distribution for a mortality problem.** A. M. Mood. 2-28-49. Unclassified.

A study of the phase of the estimation problem which determines the average life and replacement rate for physical items or assemblies. 9 pp. Illus.

RM-113 (out of print). Evaluation of materials in the elasto-plastic range. Battelle Memorial Institute. December 1948. Unclassified.

A discussion of methods of stress-strain analysis as applied to the design of supersonic vehicles, with a presentation of supporting experimental data. A review of the limitations of present theory and exposition of a framework for a set of modified relations to describe more adequately the elasto-plastic range of structural materials. 35 pp. Illus.

RM-114. Note on optimal decisions in differential equation processes. P. A. Samuelson. 3-1-49. Unclassified.

A demonstration of the falsity of the supposition that anything that everywhere maximizes the instantaneous growth of net strength will also maximize it over time in relation to optimal procedures in some Lancaster-type war models. 3 pp.

• **RM-118 (ATI 210367). Note on duels with continuous firing.** L. S. Shapley. 3-11-49. Unclassified.

A proof that mixed strategies need not be considered in certain duel situations, provided there may be a continuously variable rate of fire. 4 pp.

• **RM-122 (out of print). National income of the USSR in 1940: preliminary report.** A. Bergson and H. Heymann, Jr. 3-18-49. Unclassified.

A presentation in provisional form of the results of a series of calculations on the sources and disposition of incomes in the USSR in 1940. Main tables are (1) incomes and outlays of households, (2) consolidated net income and outlay of governmental social and economic organizations, and (3) gross national product account. 52 pp. Incorporated in R-253, *Soviet National Income and Product, 1940-48*, published by the Columbia University Press, New York, 1954. \$5.00.

• **RM-123. An integral arising in vulnerability studies.** H. H. Germond. 3-22-49. Unclassified.

An evaluation, tabulation, and approximation of an integral arising in vulnerability studies. 6 pp. Tables.

RM-128 (ATI 210368). A game-solving technique. L. S. Shapley. 3-28-49. Unclassified.

A method which detects the existence of certain two-by-two solutions of common occurrence. 2 pp. Illus. See R-216 (out of print).

• **RM-130 (AD 112397). A note on vacuum tube life.** D. J. Davis. 3-28-49. Unclassified.

An examination of the effect of cathode voltage on vacuum-tube-life distribution. 2 pp. Illus.

RM-131. The noisy duel, one bullet each, arbitrary nonmonotone accuracy. D. H. Blackwell. 3-30-49. Unclassified.

Solution of a game which is the essential element of all duels with perfect information. 6 pp. Illus. See R-216 (out of print).

• **RM-133 (AD 108315). Expected overlap.** H. H. Germond. 5-6-49. Unclassified.

Formulas, tables, and curves are given for the expected overlap of two patterns, independently aimed at the same point, and for the expected additional coverage provided by the second pattern. 7 pp. Illus.

• **RM-134 (AD 108316). An approximate solution for a coverage problem.** H. H. Germond. 4-11-49. Unclassified.

An approximate solution for the total coverage expected from a number of patterns individually aimed at the same point. 7 pp. Tables.

• **RM-135 (AD 110882). Estimation of mortality parameters.** G. W. Brown. 4-8-49. Unclassified.

A simplified method to estimate parameters for the case in which the age-specific death rate is representable as an unknown linear combination of known functions. The maximum likelihood equations are compared, and an iterative method is suggested for their solution. 3 pp.

RM-137. A three-move game with imperfect communication. L. S. Shapley. 4-15-49. Unclassified.

A supplement to previous game-theory papers. In this game, the y -player makes the first move; the x -player, the second and third moves. 6 pp.

- **RM-144 (AD 107352). Aerodynamic heating relations.** L. L. Moore. 4-18-49. Rev. 11-28-49. Unclassified.

A one-dimensional analysis of aerodynamic heating. Equilibrium temperatures of a flat plate in compressible flow are calculated as functions of velocity, altitude, and angle of attack. 27 pp. Illus.

- **RM-145. Target coverage.** H. H. Germond. 4-20-49. Unclassified.

A graphical presentation of the expected fraction of target area covered as a function of the ratio of pattern area to target area for three ratios of target dimension to aiming error. 3 pp. Illus.

- **RM-148. Some comments on an estimation problem for contaminated populations.** J. E. Walsh. 4-28-49. Unclassified.

An estimation for p , σ_1^2 and σ_2^2 for contaminated populations on the basis of n observations. 5 pp.

- **RM-151. Empirical analysis—exponential series.** H. H. Germond. 5-2-49. Unclassified.

An analysis to determine $2n$ parameters of an exponential series. The study is based on the coordinates of $2n$ points such that the values of x form an arithmetic progression. 4 pp.

RM-152. A class of games with good, pure strategies. R. E. Bellman and D. H. Blackwell. 5-2-49. Unclassified.

A presentation of conditions which ensure that the best strategies are pure for games satisfying the qualifications. 3 pp. See supplement RM-160.

- **RM-154. On the territorial coverage of Soviet official statistics for years since 1939.** A. Bergson and H. Heymann, Jr. 5-4-49. Unclassified.

An examination of (1) the Soviet territorial changes since 1939 and (2) the comprehensiveness of Soviet statistics after that year. 9 pp. Illus.

- **RM-155 (out of print). Comparison of Bergson-Heymann and Baran calculations of Soviet national income for 1940.** A. Bergson and H. Heymann, Jr. 5-4-49. Unclassified.

A tabular comparison of Bergson-Heymann and Baran calculations of Soviet national income for 1940. The tables are followed by brief explanations of the discrepancies. 8 pp. Tables. Incorporated in R-253, *Soviet National Income and Product, 1940-1948*, published by the Columbia University Press, New York, 1954. \$5.00.

RM-156. Some elementary inequalities. R. E. Bellman. 5-10-49. Unclassified.

An exposition on (1) several proofs of the inequalities discovered by Holder and Minkowski and (2) the inequality recently found by Beckenbach. 6 pp.

RM-160. An example of bluffing with pure strategies. R. E. Bellman and D. H. Blackwell. 5-18-49. Unclassified.

A supplement to RM-152, *A Class of Games with Good, Pure Strategies*. 6 pp. Illus.

- **RM-161. Are the Cominform countries using hypnotic techniques to elicit confessions in public trials?** I. L. Janis. 4-25-49. Unclassified.

An examination of Russian techniques of psychological warfare. Discussed in the study is the speculation that the Russians are using forms of hypnosis to elicit confessions from persons who might not otherwise comply with demands for a public recantation. 21 pp.

- **RM-163 (AD 108317). Area coverage with ordinary bombs.** H. H. Germond. 6-1-49. Unclassified.

A description of the relationship between (1) the number of bombs dropped, (2) the lethal area of the individual bombs, (3) the area of the target, and (4) the expected percentage of the target damaged. Separate vulnerable elements, scattered over the target area and attacked with bombs of such size that one hit is sufficient to ensure damage of any one element, are considered in the latter half of the study. 5 pp.

RM-164. On a minimum problem. R. E. Bellman. 6-9-49. Unclassified.

An attempt to fit a function of two variables by the sum of two functions of single variables. The best approximating sum is determined with the sum of the squares of the deviations minimized. 5 pp.

- **RM-165 (ATI 210369). A bomber-fighter duel.** R. E. Bellman and D. H. Blackwell. 6-14-49. Unclassified.

A study of a duel in which a fighter, capable of firing a single rocket burst, attacks a bomber, which defends itself by firing intermittently. 6 pp. Illus. See supplement RM-193.

- **RM-168. Survival chance with correlation in aim.** E. S. Quade. 6-24-49. Unclassified.
- **RM-175 (out of print). The pricing system in peacetime.** Tibor Scitovzky. 6-24-49. Unclassified.

Published as Appendix II, *Mobilizing Resources for War*, McGraw-Hill Book Company, Inc., New York, 1951.

- **RM-176 (AD 109335). Some notes on the slide-rule problem.** O. A. Gross. 6-26-49. Unclassified.

A report on the development of the slide-rule problem and on the computation of "optimal functions." 7 pp. See RM-183.

- **RM-177 (AD 108318). On the usefulness of artificial dispersion for a certain bombing problem.** J. E. Walsh. 6-28-49. Unclassified.

A derivation of criterion to ascertain the cases in which artificial dispersion is useful in maximizing expected target coverage. 4 pp.

- **RM-179 (out of print). Market mechanisms and maximization, III: dynamics and linear programming.** P. A. Samuelson. 6-29-49. Unclassified.

A supplement to P-69, *Market Mechanisms and Maximization* (out of print). 30 pp.

RM-181. An upper limit to cycle-length in a sequence of digit groups. H. H. Germond. 7-7-49. Unclassified.

A notation on a failure type which is inherent in any systematic generation of pseudo-random numbers, other than that of shuffling. 4 pp.

- **RM-183 (AD 109336). A slide-rule inequality.** O. A. Gross. 7-11-49. Unclassified.
- An evaluation of a certain slide-rule functional. A generalization of a previously known inequality is proven and associated with an algorithm presented in RM-176. *Some Notes on the Slide-rule Problem*. 6 pp.

- **RM-184. An apparent ambiguity in the interpretation of minimum risk.** L. J. Savage. 7-13-49. Unclassified.

A proof that it is in a sense equivalent to work with a mixed risk in the doctrine of minimum risk. 3 pp.

- **RM-187. Mechanical inversion of the Laplace transform.** D. V. Widder. 7-15-49. Unclassified.

Two approximate methods for inverting the Laplace transform. One is suitable for desk calculators, the other is adaptable for analogue computing. 22 pp.

RM-189. Note on some historic principles of target selection. Carl Kaysen. 7-15-49. Unclassified.

A summarization of target-selection criteria developed by the USAF. These principles are based on (1) military importance, (2) percentage of direct military use, (3) depth, (4) economic vulnerability, (5) physical vulnerability, and (6) location and size of targets. 10 pp.

- **RM-190. A problem in Fourier transforms connected with the design of an antenna.** D. V. Widder. 7-20-49. Unclassified.

A solution to the design problem of an antenna in Fourier sine-series. 17 pp. Illus.

RM-191 (ATI 210604). Expected coverage when all bombs are aimed at the center of the target. H. H. Germond. 7-18-49. Unclassified.

A report on expected proportional coverage. It is assumed that (1) the target is circular, (2) many bombs are independently aimed at the center of the target, and (3) these bombs are subject to a circular Gaussian distribution law. 6 pp. Illus.

- **RM-193 (ATI 210321).** A bomber-fighter duel—II. D. H. Blackwell and M. Shiffman. 7-25-49. Unclassified.

A supplement to RM-165, *A Bomber-Fighter Duel*. 9 pp.

- **RM-194. Empirical analysis: power series.** H. H. Germond. 7-21-49. Unclassified.

An empirical analysis to determine parameters in a power series. The procedure is based on knowing the coordinates of points where the values of x form a geometric progression. 8 pp.

- **RM-195 (ATI 210322).** The problem of Cunningham and Hynd. D. A. Darling. 8-8-49. Unclassified.

An investigation to determine the mean survival time and survival probability of a target from a burst of shots. The aim of the gunner is assumed to be a stochastic wandering process around the center of a target. 20 pp.

- **RM-196. A theorem on parametric Boolean functions.** W. V. Quine. 7-27-49. Unclassified.

Establishment of a theorem of set theory in order to supplement a concurrent study of N. Dalkey on the utility concept. 4 pp. See supplement RM-199.

- **RM-197. Application of theory of games to identification of friend and foe.** R. E. Bellman, D. H. Blackwell, and J. P. LaSalle. 7-28-49. Unclassified.

An identification of friend and foe by game-theory analysis for a player who must choose the best strategy from two courses of action. 15 pp. Illus.

RM-198 (out of print). Economic survey report: construction materials for aircraft and guided missiles, electric-power supply and requirements. Battelle Memorial Institute. 5-31-49. Unclassified.

A study of the national supply of electric power in 1949, 1950, and 1951. The memorandum discusses the national power situation, the eight power regions, equipment and energy costs, load composition, and power supply in time of war. 75 pp. Illus.

- **RM-199. Commutative Boolean functions.** W. V. Quine. 8-10-49. Unclassified.

A note supplementing RM-196 and presenting the second of two theorems of set theory used in a study of the utility concept. 5 pp.

- **RM-201 (ATI 210323).** Graphical solution of 3×3 matrices. L. S. Shapley. 8-1-49. Unclassified.

A method of solving 3×3 game matrices by graphical representation. 4 pp. Illus.

- **RM-202 (ATI 210324).** Total reconnaissance with total countermeasures: simplified model. Seymour Sherman. 8-5-49. Unclassified.

A game-theory model which determines the effect of total reconnaissance and total countermeasures on the payoff and desirable strategies. Only a finite set of pure strategies is available to each player. 18 pp. Also published as P-106. See also RM-203.

- **RM-203 (ATI 210325).** Solutions of a special reconnaissance game. R. L. Belzer. 8-10-49. Unclassified.

A presentation of solutions for a special case of a general reconnaissance model previously investigated in RM-202. 23 pp. Illus.

RM-204. Note on the solution of convex games. L. S. Shapley. 8-2-49. Unclassified.

A method of selecting a finite subset from an arbitrary set of linear functions for convex regions of arbitrary finite dimension. 4 pp.

- **RM-205. A tactical reconnaissance model.** L. S. Shapley. 8-2-49. Unclassified.
A study of the advisability of reconnaissance before a single bombing mission on a single target of uncertain military worth. 6 pp.
- RM-206 (ATI 210326). A generalization of the silent duel, two opponents, one bullet each, arbitrary accuracy.** M. A. Girshick. 8-1-49. Unclassified.
A generalization of a duel, considering several cases in which the bullets may be duds and the hits not lethal. 8 pp.
- RM-207a (ATI 68782). Soviet military intelligence: comments on the book, *Handbook for spies*, by Alex Foote.** Social Science Division. 8-12-49. Rev. 10-12-49. Unclassified.
A review of the *Handbook for Spies* by Alexander Foote. The errors and distortions in the book are indicated. 30 pp.
- **RM-208. Reconnaissance in game theory.** H. F. Bohnenblust, L. S. Shapley, and S. Sherman. 8-12-49. Unclassified.
A study of the influence of reconnaissance on the strategies of the players and on the value of the game. In the case studied, one player uses a fixed type of reconnaissance and the second player attempts neither reconnaissance on his own nor countermeasure. 18 pp.
- **RM-210 (out of print). The Le Chatelier principle in linear programming.** P. A. Samuelson. 8-4-49. Unclassified.
An extended study of the Le Chatelier principle which determines a cheapest diet conforming to prescribed nutritional standards. The extension considered is the effect of an increased price of an *i*th food in the linear programming problem. 18 pp. Illus.
- RM-212. On non-zero-sum games and stochastic processes.** R. E. Bellman and J. P. LaSalle. 8-19-49. Unclassified.
An introduction to a class of stochastic games which arose in an attempt to find an approach to non-zero-sum games. 12 pp.
- **RM-213. The duel with time of flight not zero.** E. S. Quade. 8-17-49. Unclassified.
An analysis of a duel in which the time of flight of the shots is not assumed to be zero. The survival chance of each contestant against the uninterrupted fire of the other is determined. 8 pp. Illus.
- RM-215. Solutions of a class of continuous games.** J. P. LaSalle. 8-19-49. Unclassified.
A report on a general class of games whose solutions are discrete probability functions. A special case is presented in which one player has a pure best strategy. 11 pp.
- **RM-218. On functions of relations with especial reference to social welfare.** W. V. Quine. 8-19-49. Unclassified.
A method of transforming certain functions of a satisfactory ordering of goods into logical equivalents. Special reference is given to social welfare. 15 pp.
- RM-219. A loud duel with equal accuracy where each duelist has only a probability of possessing a bullet.** M. Girshick and D. H. Blackwell. 8-18-49. Unclassified.
A consideration of optimum strategies dependent on the relative magnitude of the probabilities of possessing a bullet. 4 pp.
- **RM-224. A mathematical model of an air transportation system.** T. W. Anderson, K. J. Arrow, and J. E. Walsh. 8-26-49. Unclassified.
A development of a mathematical model of an air transportation system in order to study the most efficient program of operations for transporting a given amount of goods between two fixed locations per unit of time. 7 pp.
- **RM-226. Principles of the REAC.** A. S. Mengel. 1-19-49. Unclassified.
A study of the capabilities of the Reeves Electronic Analogue Computer. Its principles of operation and a sample problem are analyzed. 9 pp. Illus.

- **RM-227. Photoelectric coverage machine.** B. T. Himes. 8-23-49. Unclassified.

A description of a photoelectric coverage machine model. For an arbitrarily shaped target, the machine rapidly determines (1) area, (2) probability of a hit for a given point of aim, and (3) point of aim to maximize the probability of a hit. 8 pp. Illus.

- **RM-233. Application of concepts from kinetic theory of gases to interception problem.** Richard Schamberg. 8-29-49. Unclassified.

An application as an analogy of the kinetic theory of gases to those phases of the intercepting problem which involve random motion of the interception or intercepted aircraft. A derivation of equations for the mean free paths of bomber and fighter airplane molecules. An interpretation of the effective diameter of such airplane molecules. 14 pp. Illus.

- **RM-234. A note on the Monte Carlo method and the potential equation.** R. E. Bellman. 9-1-49. Unclassified.

A discussion of the possibility of applying the Monte Carlo method to obtain numerical solutions of the potential equation. 3 pp.

- RM-236 (out of print). Summary of REAC experience.** W. F. Gunning and A. S. Mengel. 9-8-49. Unclassified.

A summary of RAND experience with the Reeves Electronic Analogue Computer. Presented in the study are (1) an outline of the modifications, (2) examples of generalized operational techniques, and (3) personnel requirements and calibration and maintenance procedures. 60 pp. Illus.

- RM-239 (AD 101288). Air battle theory: statistical survival analysis for close-controlled interceptors versus bombers.** G. E. Gompf. 8-29-49. Unclassified.

An analysis of a simplified air battle model. It is assumed that (1) continuous close control of each interceptor can be maintained throughout the battle and (2) the bomber and interceptor losses represent practical upper limits to the attrition rates for air battle. 7 pp. Table.

- RM-240. Basic survival-probability expressions for air combat models.** G. E. Gompf. 8-22-49. Unclassified.

An analysis of a simplified air battle model constructed with a survival-probability distribution between broadcast and close control. The two types of control are assumed to represent lower and upper bounds for the bomber-survival rate in an interceptor attack wave. 4 pp. Illus.

- **RM-241. Comparison of reconnaissances.** D. H. Blackwell. 9-15-49. Unclassified.

A representation of every reconnaissance better than a given reconnaissance for the special case in which the opponent has two moves. 7 pp.

- RM-242. Successive approximation.** H. H. Germond. 8-15-49. Unclassified.

An iterative process which determines successively closer approximations to the solution of an equation in one unknown. 4 pp.

- **RM-243 (ATI 210327). On the equality $\min \max = \max \min$, and the theory of games.** Max Shiffman. 9-22-49. Unclassified.

A new elementary proof of von Neumann's minimum-maximum theorem. The possibility of determining an approximate saddle-point to the original problem by the solution of a system of equation solutions is presented. 16 pp.

- **RM-245 (AD 102897). Climb path for least elapsed time.** N. C. Peterson. 10-7-49. Unclassified.

An examination of an engineering method which determines the path a jet-powered airplane must follow to achieve a specified speed and altitude in the least elapsed time. An analysis of the suitability of the method and the conditions under which it becomes unrealistic. 13 pp.

- **RM-246 (AD 102896). A study to determine the flight paths which require minimum time and minimum fuel for a typical present-day interceptor.** T. F. Kirkwood. 9-15-49. Rev. 3-1-50. Unclassified.

An approximate method to determine the flight technique by which an airplane may reach a specified speed and altitude in minimum time or with minimum fuel consumed. Cases are considered in which the distance covered is (1) unrestricted and (2) specified. 18 pp. Illus.

- **RM-248. Particle histories for plane slabs.** Herman Kahn. 12-24-48. Unclassified.
A preliminary account of work on the application of sampling techniques to the problem of determining the transmission of radiation through shields in which an attempt is made to compromise between a large number of easily calculated histories and a smaller number of more complicated histories. 19 pp. Illus.
- **RM-250. On a particular non-zero-sum game.** R. E. Bellman and D. H. Blackwell. 9-27-49. Unclassified.
A detailed consideration of a particular non-zero-sum game of attrition. 16 pp.
- RM-251. The potentialities of the photoelectric coverage machine.** H. H. Germond and B. T. Himes. 9-27-49. Unclassified.
An evaluation of the capabilities of the photoelectric target-coverage machine. Problems considered are classified as (1) hit probabilities, (2) coverage problems, and (3) damage problems. 4 pp.
- **RM-252 (ATI 210328). Composite targets: n identical elements.** H. H. Germond. 9-29-49. Unclassified.
An examination of the survival probabilities of a target complex made up of n elements, each of which has the same probability of being damaged. 23 pp.
- RM-255. Experimental program.** J. R. Richardson. 10-3-49. Unclassified.
An outlined research program to determine the experimental information necessary for an adequate shield design. 9 pp. Illus.
- **RM-260-1 (ATI 210621). Reliability of progress curves in airframe production.** A. A. Alchian. 10-7-49. Rev. 2-3-50. Unclassified.
A presentation of statistical tests which determine the similarity of the functions among various airframe manufacturers based on World War II data. An assessment of the prediction reliability is made with these curves. 33 pp. Illus.
- **RM-261. On the thermodynamics of solids: critical discussion of the Debye and Raman theories with applications.** H. K. Kallmann. 8-12-49. Unclassified.
A critical survey of the Debye and Raman theories of crystal dynamics as applied to the calculation of thermodynamic properties. Numerical examples are presented for aluminum, magnesium, lithium, and carbon. 48 pp. Illus.
- RM-262. Limitations of focused aperture antennas.** R. S. Wehner. 10-10-49. Unclassified.
A discussion of the properties of focused aperture antennas, based on Fresnel diffraction theory, for the case of a continuous plane circular aperture. The analysis shows that while focused apertures have certain advantages over conventional antennas, their performance is clearly limited by exactly the same diffraction effects which govern that of unfocused or uniformly illuminated apertures. 25 pp. Illus.
- **RM-267. Illustrative example of application of Koopmans' transportation theory to scheduling military tanker fleet.** M. M. Flood. 10-17-49. Unclassified.
An analysis of the operation of a U.S. military tanker fleet to determine optimum routes throughout the world for delivery of bulk petroleum products to the military. 18 pp. Illus. See also RM-406.
- RM-268. Games with many moves.** L. S. Shapley. 10-17-49. Unclassified.
A summarization of three papers on information in extensive games as they apply to simplifying the solution of multimove games. 6 pp.
- **RM-271 (ATI 174368). A note on the power function of the Wald-Wolfowitz tolerance limits for a normal distribution.** A. W. Marshall. 10-21-49. Unclassified.
An investigation of the power function of the Wald-Wolfowitz method. This method (1) constructs tolerance limits for a normal distribution and (2) determines a method which approximates an integral with limits of integration that are random variables. 6 pp.

- **RM-272 (ATI 210329). The rate of dissociation of air.** Arnold Benton. 10-21-49. Unclassified.

Tables of the variation with time of the composition of air which is suddenly subjected to high temperatures. The calculations are made at intervals of 500°K for the temperature range 3000°K to 6000°K and at each temperature for three different pressures—0.1, .01, and .001 atmosphere. 19 pp. Illus.

- **RM-273 (out of print). A compilation of physical and chemical data pertaining to self-igniting fuels for ramjet propulsion.** Y. M. Claeys. 8-15-49. Unclassified.

A list of 147 chemical compounds which have low activation energies and relatively high heats of combustion and flame stabilities and which may be useful in ramjet engines either as fuels or as fuel additives. 42 pp. Tables.

- **RM-274. Determination of expected coverage and of expected damage: single bomb of large lethal area.** H. H. Germond. 10-28-49. Unclassified.

An application of a photoelectric coverage instrument which measures expected target coverage and expected damage value. It is assumed that the target is attacked with a bomb of large lethal area. 17 pp. Illus.

- **RM-278 (out of print). National income and the disposition of gross national product in adjusted rubles—USSR—1940.** A. Bergson and H. Heymann, Jr. 11-1-49. Unclassified.

A revision of RM-122, *National Income of the USSR in 1940: Preliminary Report* (out of print). 16 pp. Tables. Incorporated in R-253, *Soviet National Income and Product, 1940-48*, published by the Columbia University Press, New York, 1954. \$5.00.

- RM-279 (AD 114193). Notes on ($m \times 2$) evaluation matrices for special systems analysis applications.** Jean Wylie. 1-10-50. Unclassified.

A method to determine the optimal strategy of general ($m \times 2$) matrices arising in game-theory problems in order to facilitate the application of this field of mathematics to practical systems analyses. This evaluation (1) indicates the effects of parameter shifts and (2) suggests general mathematical solutions for game theory problems. 32 pp. Illus.

- **RM-283 (out of print). National economic accounts of the USSR in 1948: preliminary report.** A. Bergson and H. Heymann, Jr. 11-10-49. Unclassified.

Some provisional results of calculations of Soviet incomes and outlays both of households and government agencies. 62 pp. Tables. Incorporated in R-253, *Soviet National Income and Product, 1940-48*, published by the Columbia University Press, New York, 1954. \$5.00. See also RM-287 (out of print).

- RM-284 (ATI 174366). Some statistical problems connected with stochastic processes.** T. W. Anderson and D. A. Darling. 11-11-49. Unclassified.

A treatment of the problem of testing the hypothesis that a sample of n independent, identically distributed random variables has the common continuous distribution function $F(x)$ specified in advance. The method used reduces the problems to considerations in the theory of continuous Gaussian stochastic processes. 12 pp.

- **RM-286 (ATI 210372). Pursuit path method: maneuvering bomber.** J. A. Wilson and J. R. Lind. 11-16-49. Unclassified.

A graphical method in which pursuit course attacks, generated as a bomber turns, are determined in relative bomber motion. From this system of plotting, the maneuvering bomber attack plots may be used as overlays on nonmaneuvering attack plots. This system is useful for analyzing interceptor load factors at any range or azimuth conditions, using nonmaneuvering bomber attack equations. 9 pp. Illus.

- **RM-287** (out of print). **Disposition of national product of the USSR in 1948 in terms of adjusted ruble prices.** A. Bergson and H. Heymann, Jr. 11-17-49. Unclassified.
A supplement to RM-283, *National Economic Accounts of the USSR in 1948: Preliminary Report* (out of print). 14 pp. Tables. Incorporated in R-253, *Soviet National Income and Product, 1940-48*, published by the Columbia University Press, New York, 1954. \$5.00.
- **RM-289. Occurrence of improbable states in a modified Ehrenfest model—part I.** R. E. Bellman and T. E. Harris. 11-17-49. Unclassified.
A study of a physical model with a continuous time parameter, closely related to the Ehrenfest model, to help reconcile certain apparent incompatibilities between thermodynamic laws and classical mechanics. 13 pp. See Part II, RM-321.
- RM-291** (out of print*). **Social choice and individual values.** K. J. Arrow. 7-28-49. Unclassified.
Published as *Social Change and Individual Values*, Cowles Commission Monograph No. 12, John Wiley & Sons, New York, 1951. \$2.50.
- **RM-296. A numerical scale for partially ordered utilities.** N. C. Dalkey. 12-5-49. Unclassified.
An extension of a numerical scale of von Neumann and Morgenstern to a wide class of partially ordered utilities. By this extension a numerical scale may be determined up to a linear transformation and may extend the partial order to a complete order. 21 pp. Illus.
- **RM-299** (out of print). **The economic sinews of modern war: physical limitations on war production.** Stephen Enke. 5-18-49. Unclassified.
A report on the munitions of the U.S., the United Kingdom, Canada, Germany, and Japan in 1944. By indices of output and input, the munitions outputs are compared with the total economy-wide consumption of metals and energy. 27 pp. Illus.
- **RM-302. A model for the reliability of complex mechanisms.** T. E. Harris. 12-5-49. Unclassified.
A report on determining how long it will be before all elements are simultaneously out of repair, when several elements are used in parallel in a complex mechanism. 7 pp.
- **RM-303 (ATI 174367). On the Hamiltonian game (a traveling-salesman problem).** J. B. Robinson. 12-5-49. Unclassified.
A method which solves a problem, similar to that of the traveling salesman, of finding the shortest closed curve containing n given points in the plane. 10 pp.
- RM-306 (AD 108319). Expected coverage with conventional bombs when rectangular patterns are employed against rectangular targets.** H. H. Germond. 8-5-59. Unclassified.
An investigation of the expected coverage when a large number of conventional high-explosive bombs are used in an attack on a target of considerable area. 15 pp. Illus.
- **RM-309. A circular probability grid.** H. H. Germond. 8-24-48. Unclassified.
A tabular presentation of the number of cells in each circle of the probability grid. The value of the integral over each circle of cells and the grid having cells of equal probability are also given. 4 pp. Illus.
- **RM-310 (ATI 210622). Performance effects of refueling.** C. V. Sturdevant III. 2-1-50. Unclassified.
A study of certain performance effects of refueling turbine-powered aircraft. Generalized charts show the variance of combat radius, refueling distance, and target altitude with bomb load and fuel load which are expressed as fractions of the initial gross weight of the bomber. 14 pp. Illus. See companion piece RM-453.

RM-312 (ATI 210603). Bomber formations analysis: simplified air battle attrition theory. Jean Wylie. 12-20-49. Unclassified.

Another in a series of air battle studies. Generalized expressions for the survival of both bombers and escorts are described by the ratio of bombers to escorts and by the intensity and number of interceptor attacks, and are based on limiting tactical doctrine postulates. 16 pp.

- **RM-316 (ATI 210623). Maneuvering and scanning barriers for all-weather interceptions: a graphical method.** W. H. Phinizy. 1-5-50. Unclassified.

A presentation of graphic methods to determine interceptor positioning limits or barriers that occur during all-weather interception. A simplified minimum distance track is substituted for usual collision courses and pursuit-curve attacks. The maneuvering-and-scanning barriers around the fighter, beyond which no combat is probable, are also estimated. 46 pp. Illus.

RM-317 (ATI 210624). Application of the photoelectric machine: expected damage by a single weapon. B. T. Himes. 1-5-50. Unclassified.

A report which illustrates applications of the Photoelectric Coverage Machine. An evaluation of the expected damage to a target complex by a single weapon whose effective lethalties differ for various types of target elements. 13 pp. Illus.

- **RM-318 (ATI 210330). A preliminary model for an air battle.** E. S. Quade. 7-29-49. Unclassified.

A preliminary air battle model to determine the survival probabilities in a given situation. A formation of bombers entering defended territory is detected by an early-warning network. Long-range fighters, under broadcast control, take off to intercept the raid. 6 pp. Illus.

- **RM-319 (ATI 210331). Local defense of targets of equal value.** R. L. Belzer, M. Dresher, and O. Helmer. 11-28-49. Unclassified.

An analysis to determine optimal attack and defense strategies. Both opponents know each other's capacities, but not each other's choice of strategies. 8 pp. See RM-320 and RM-329.

- **RM-320 (ATI 210332). Local defense of targets of equal value: extension of results.** M. Dresher and O. A. Gross. 1-12-50. Unclassified.

A supplement to RM-319, *Local Defense of Targets of Equal Value*. 17 pp. Illus. See RM-329.

- **RM-321 (ATI 210605). Occurrence of improbable states in a modified Ehrenfest model—part II.** R. E. Bellman and T. E. Harris. 1-13-50. Unclassified.

A supplement to RM-289, Part I of same title. 6 pp.

- **RM-323 (ATI 210625). On the expected damage from single bomb drops.** W. E. Frye and E. V. Stearns. 1-19-50. Unclassified.

An evaluation of the mean damage inflicted on a circular target by a single bomb for (1) a circular Gaussian distribution of impacts and (2) a distribution which analyzes a radar bombing equipment. The damage is shown graphically as a function of the lethal radius of the bomb and the standard deviation of the probability distribution of impact. 24 pp. Illus.

- **RM-328 (out of print). Disposition of the gross national product of the USSR in 1937, 1940, and 1948.** A. Bergson and H. Heymann, Jr. 1-24-50. Unclassified.

A comparison of Soviet resource allocation in 1937, 1940, and 1948 based on national income studies for each of those years. 26 pp. Tables. Incorporated in R-253, *Soviet National Income and Product, 1940-48*, published by the Columbia University Press, New York, 1954. \$5.00.

- **RM-329 (ATI 210333). Local defense of targets of equal value: completion of results.** O. A. Gross. 1-25-50. Unclassified.

A supplement to RM-319, *Local Defense of Targets of Equal Value*, and RM-320, an extension of the study. 5 pp. Illus.

- **RM-330 (ATI 210334). The circular coverage function.** H. H. Germond. 1-26-50. Unclassified.

A condensation of tabulated values of the circular coverage function, an integral representing the probability that a missile will hit a circle of radius r if it is aimed at a point a distance r from the

center of the circle and if it is subject to a Gaussian impact-probability law of unit standard deviation. 16 pp. See extension RM-2765-PR.

RM-333 (AD 116559) (out of print). Information on the plastic properties of aircraft materials and plastic stability of aircraft structures at high temperatures. Battelle Memorial Institute. 12-15-49. Unclassified.

A presentation of data pertinent to the problem of creep stability of columns and a description of some additional data on the effect of combined stresses on room-temperature plastic properties of some aircraft materials. 79 pp. Illus.

RM-335 (ATI 210627). A study of the factors affecting the choice of frequency for an airborne microwave relay system. I. K. Williams. 2-2-50. Unclassified.

A discussion of (1) the atmospheric absorption of microwaves in the region 1 to 2 cm, (2) the security of the system, (3) the power required at each transmitter, and (4) the fading due to multipath transmission. 41 pp. Illus.

● **RM-336 (ATI 210628). The economics of Soviet agriculture.** J. A. Kershaw. 2-6-50. Unclassified.

An evaluation of the Soviet agricultural program. Several problems discussed are (1) the organization of agricultural production, (2) the results of collectivization, (3) the farm labor productivity, (4) the basic conditions of Soviet agricultural development, and (5) the agricultural effects of war. 37 pp.

● **RM-339 (AD 116551) (out of print). Table of Q functions.** J. I. Marcum. 1-1-50. Unclassified.

A tabulation on IBM cards of six-place tables of the function $Q(\alpha, \beta) = \int_{\beta}^{\infty} v \exp [-(v^2 + \alpha^2)/2] I_0(\alpha v) dv$, with β given in steps of 0.1 and α given in steps of 0.05. The Q function arises in the problem of finding the cumulative probability distribution function for the envelope of sine wave plus noise, the density function being the integrand. 189 pp. For most purposes the tables in R-234, *Offset Circle Probabilities*, will be found more convenient.

● **RM-346 (ATI 210630). The German munitions production index: World War II.** R. T. Nichols. 2-2-50. Unclassified.

A publication of the annual and monthly index numbers for German munitions³ production as a whole, and for several groups and subgroups in World War II. 26 pp. Tables.

● **RM-350 (ATI 210632). The Rayleigh-Ritz method in compressible flow problems.** H. I. Ansoff and R. D. Specht. 3-15-50. Unclassified.

An application of the Rayleigh-Ritz method to the problem of the steady, two-dimensional flow of a perfect, compressible fluid. 16 pp. Illus.

● **RM-357 (ATI 210634). On positive transformations.** R. E. Bellman and T. E. Harris. 3-27-50. Unclassified.

A discussion on positive transformations encountered in connection with Markoff processes and with games of timing. 14 pp. Illus.

● **RM-359 (ATI 210335). n targets of differing vulnerability with attack stronger than defense.** O. A. Gross. 4-3-50. Unclassified.

A study of an attack-defense model with an interpretation by means of a numerical example. 8 pp.

● **RM-363 (ATI 210636). A class of integral equations.** Richard Latter. 3-1-50. Unclassified.

An extension of the Wiener-Hopf technique by which it is possible to obtain explicit solutions to convolution-type integral equations with finite limits of integration for the cases in which the kernel of the integral equation can be represented as an arbitrary sum of polynomials times decaying exponentials. 20 pp. See also RM-372.

RM-365 (ATI 210637). The exploitation of superstitions for purposes of psychological warfare. J. M. Hungerford. 4-14-50. Unclassified.

An examination of the superstitions evidenced in World War II and the techniques used to exploit these beliefs for psychological warfare. 30 pp.

- **RM-366 (ATI 210638). On the min max of a bilinear form.** S. S. Walters. 4-14-50. Unclassified.

A method which determines the min max of a bilinear form is defined over the Cartesian product of two compact sets, each of which is in a Euclidean space. 4 pp.

- **RM-367 (ATI 210373). The economic war potential of the United States and the Soviet Union.** J. Hirshleifer and J. A. Kershaw. 4-17-50. Unclassified.

A comparison of the economic war potential of the U.S. and USSR, estimated (1) for 1950 and (2) between 1955 and 1960. 32 pp. Illus.

- **RM-370 (ATI 210639). Estimation in truncated sampling processes.** Max Halperin. 5-1-50. Unclassified.

An examination of estimation procedures for truncated sampling processes to determine which is asymptotically "best." Considered in the study are (1) processes with fixed points of truncation, (2) a truncated mortality process with renewal allowed, and (3) processes with random points of truncation. 57 pp. Illus.

- **RM-371 (ATI 210640). The political meaning of the Kostov trial in Sofia, Bulgaria, December, 1949.** E. Bernaut and N. C. Leites. 4-5-50. Unclassified.

An interpretation of the political significance of the Kostov trial in the development of Soviet Communism. Kostov, motivated by specific political considerations, promulgated an alternative "line" for the Communist Parties in the Soviet Union and the satellite countries to follow. 18 pp.

- **RM-372 (ATI 210641). Asymptotic solutions for a class of integral equations and their application to neutron transmission through a finite slab.** Richard Latter. 4-24-50. Unclassified.

Fourier transform methods for obtaining asymptotic solutions of convolution-type integral equations with finite limits of integration with their further application to the transmission and reflection of particles from an isotropically scattering plane slab of finite thickness. 28 pp. See also RM-363.

- **RM-373. On Mandelbaum's study of the industrialization of backward areas.** K. J. Arrow and S. S. Arrow. 4-25-50. Unclassified.

A review of *The Industrialization of Backward Areas* by K. Mandelbaum (published by Basil Blackwell & Mott, Ltd., Oxford, 1946). An attempt is made to isolate its logical structure and presuppositions and to study the basis that they afford for quantitative prediction and for planning the industrialization of backward areas. 20 pp.

- **RM-376 (ATI 210336). A method for choosing among optimum strategies.** G. W. Brown. 5-2-50. Unclassified.

An extension of the min-max principle to determine a preferred optimum strategy in discrete games whose solutions are not unique. 4 pp. Illus. See also RM-386 and RM-387.

- **RM-386 (ATI 210642). "Best" strategies.** J. C. C. McKinsey. 4-25-50. Unclassified.
- A study of "best" strategies which are optimum and take advantage of the mistakes of the opponent. 7 pp. See RM-376 and RM-387.

- **RM-387 (ATI 210643). Some remarks on best strategies.** R. L. Belzer. 5-9-50. Unclassified.

A discussion of the geometrical significance of best strategies as defined by McKinsey and Brown. 6 pp. Illus. See RM-376 and RM-386.

- **RM-388 (ATI 78026). Human factors in systems analysis.** Herbert Goldhamer. 4-15-50. Unclassified.

A systems-analysis approach to the relation between the optimization of certain critical parameters and organized human action. 29 pp.

- **RM-391 (AD 108423) (out of print). Derivation of a wing weight formula for a thin wing structure.** F. R. Shanley, J. W. Wechsler, and W. R. Micks. 11-27-50. Unclassified.
An examination of the limiting case of a wing of minimum thickness. The deflection characteristics are investigated and the weight equations used to get an indication of the parameters involved and the conditions under which the "solid" wing might compare favorably with the more conventional types of construction. 24 pp. Illus. Incorporated in R-222, *Weight-Strength Analysis of Aircraft Structures* (out of print), published by McGraw-Hill Book Company, Inc., New York, 1952. \$8.50.
- **RM-393 (ATI 210645). Profits and subsidies in Soviet economic accounts.** A. Bergson and H. Heymann, Jr. 5-19-50. Unclassified.
A discussion and explanation of Soviet practices in computing total profits of economic organizations in the USSR. National-product calculations are reworked to take into account the unusual practice of not deducting losses. 41 pp.
- **RM-398 (AD 109271). The preparation of high-purity boron.** Battelle Memorial Institute. 3-30-50. Unclassified.
A summary of the work on the preparation of high-purity boron by the hot-wire reduction of boron tribromine. 26 pp. Illus.
- RM-400 (ATI 210375). Two-airplane formation design: generalized theory.** J. A. Wilson and J. Wylie. 5-25-50. Rev. 6-13-50. Unclassified.
An analytical treatment of the two-element bomber formation to determine the effect of certain formation types on bomber and escorting aircraft attrition in air battle. 21 pp. Illus.
- **RM-406 (ATI 210646). Routing of empties for fixed-schedule transportation.** J. B. Robinson and J. E. Walsh. 6-12-50. Unclassified.
An outline for a method of determining the minimum number of carriers required and the route corresponding to that number of carriers in a fixed-schedule transportation plan. 5 pp. See RM-267.
- **RM-407 (ATI 210647). A note on the Hitchcock-Koopmans problem.** J. B. Robinson. 6-15-50. Unclassified.
A variation of the method of M. M. Flood for the complete solution of the Hitchcock-Koopmans problem. 4 pp.
- **RM-408 (ATI 210337). A continuous Colonel Blotto game.** O. A. Gross and R. A. Wagner. 6-17-50. Unclassified.
A memorandum on a continuous two-person, zero-sum game. Colonel Blotto and the enemy are confronted with a situation in which (1) Blotto has at his disposal a total of $B(>0)$ units of attack, (2) the enemy has $E(>0)$ units of like character, and (3) they are to attack simultaneously and in full force a set of n hills of different values, with prescribed payoffs. 12 pp. Illus. See supplement RM-424.
- **RM-411 (ATI 80215). Political trends in Japan.** A. M. Halpern. 6-20-50. Unclassified.
An analysis of political developments in Japan as they explain the Communist Party gains between 1947 and 1949. A further analysis of the vote received by them in the 1949 elections throws light on the reasons for gaining the support they have, and the geographical distribution of their strength. 26 pp. Illus.
- **RM-412 (out of print). A note on best strategies.** K. J. Arrow. 6-22-50. Unclassified.
A simple proof that in games of strategy every optimum strategy which is not best is dominated by a best strategy, from which an immediate consequence follows that every finite game has a best strategy. 2 pp.
- **RM-413 (AD 108424). The expected coverage of a small circular target by a number of circular bombs.** R. H. Dishington. 6-26-50. Unclassified.
Plots of the expected or average coverage as a function of bomb lethal radius, target radius, and aiming error using simplified circular bomb coverages and targets. 11 pp. Illus.

- **RM-414 (ATI 210338). Solution of a game with constraints.** R. A. Wagner. 6-30-50. Unclassified.
An example of a game with constraints solved by finding fixed points in a mapping process. 7 pp. Illus.
- **RM-417 (ATI 210339). Calculation of specific impulse and other rocket performance characteristics.** W. B. White, H. K. Kallmann, and C. P. Bahrman. 6-1-50. Unclassified.
A presentation of a short method for calculating specific impulse and other performance characteristics of rocket motors. It applies to a group of liquid propellants and smokeless powders. 27 pp.
- **RM-421 (ATI 210340). The thermodynamic properties of silicon in the solid, liquid, and gaseous states.** F. J. Krieger. 7-1-50. Unclassified.
Tabulations of calculated values of the heat capacity at constant pressure, the heat content function, the entropy, and the free-energy function for silicon as a crystalline solid, as a liquid, and as an ideal gas. 13 pp.
- **RM-424 (ATI 210341). The symmetric Blotto game.** O. A. Gross. 7-19-50. Unclassified.
An extension of RM-408, *A Continuous Colonel Blotto Game*. A method of constructing a solution for the general symmetric case is given. 6 pp. Illus.
- **RM-425 (ATI 210649). The regional structure of Soviet retail prices.** J. G. Chapman. 7-20-50. Unclassified.
A preliminary to a larger study of the retail prices in the Soviet Union in which an effort is made to determine the representativeness of Moscow price movements. The regional structure of prices and the changes in this structure are described, the rationale of Soviet regional price-fixing is discussed, and the changes in the position of Moscow prices in relation to average prices for the entire USSR are analyzed. 144 pp. Illus.
- **RM-427 (ATI 210650). A reduction of general two-person games without side payments.** D. H. Blackwell and H. F. Bohnenblust. 7-24-50. Unclassified.
A demonstration that the process of reduction of the payoff matrices of a two-person non-zero-sum game leads to a unique result, in which the Nash points are precisely those of the original game. 8 pp. Illus.
- **RM-428 (ATI 210651). Petroleum industry of Germany during the war.** A. L. Skogstad. 4-26-50. Unclassified.
A study of the major factors contributing to the success of the Allies in disrupting the German petroleum industry in 1944. Specific points studied are (1) the principal characteristics of that industry, (2) German measures to ensure an adequate supply, (3) industrial recuperability, (4) plant vulnerability to bombing, and (5) methods used by the Allies to stop production. 43 pp.
- **RM-429 (ATI 210652). On Nicolson's formula for capacitance.** Edgar Reich. 7-28-50. Unclassified.
A critical examination of the validity of J. W. Nicolson's integral formula as an expression of the exact value of the capacitance of a circular parallel plate condenser. 5 pp.
- **RM-432 (ATI 210653). An approximate method for the determination of maximum ramjet impulse.** W. B. White and C. P. Bahrman. 6-14-50. Unclassified.
A description of an approximate method with graphs giving the maximum obtainable ramjet impulse and the corresponding mixture ratio for a generalized fuel of known heat of combustion. 10 pp. Illus.
- **RM-433 (ATI 210654). Best strategies for continuous games with a continuous payoff.** I. L. Glicksberg. 8-10-50. Unclassified.
A proof that best strategies exist for the continuous two-person zero-sum game with a continuous payoff function. 6 pp.

- **RM-435 (ATI 210655). Games played over nonconvex sets of mixed strategies.** I. L. Glicksberg. 8-16-50. Unclassified.

A demonstration of a necessary and sufficient condition that a finite game (or a continuous game with continuous payoff), played over closed sets of the sets of all mixed strategies, satisfies the minimax relation. 2 pp.

- **RM-436 (AD 102293). Tables of contributions to thermodynamic properties due to gas imperfection.** W. B. White. 8-15-50. Unclassified.

Tables of the contribution to the thermodynamic properties due to pressure for nonpolar gases and for polar molecules for the properties, internal energy, enthalpy, free energy, entropy, heat capacity at constant pressure, and heat capacity at constant volume. 77 pp.

- **RM-438 (out of print). Summary report: cyclic heat-transfer studies with gases.** Battelle Memorial Institute. 6-30-50. Unclassified.

A description of the final experimental work of temperature measurement, apparatus calibration, and heat-transfer measurement using a cyclic heat-transfer technique to determine heat-transfer coefficients. The cyclic technique is evaluated with particular attention to the accuracy of the method. 32 pp. Illus.

- **RM-442 (AD 103216). Thermodynamic properties of real gases for use in high-pressure problems.** H. K. Kallmann. 5-15-50. Unclassified.

A presentation and discussion of the equations, derived from an equation of state for real gases, which are suitable for the calculation of the thermodynamic properties varying with temperature and pressure for real gases. 44 pp.

- **RM-444 (ATI 210342). A remark on the silent duel with positive initial accuracy, and on associated silent and noisy duels.** L. S. Shapley. 3-30-50. Unclassified.

A more elegant description of the solution of the duel proposed and solved in RM-108 (withdrawn); and a discussion of a relationship between the solution of the silent duel and that of the associated noisy duel. 3 pp. Illus.

- **RM-445 (ATI 210343). The silent duel, one bullet versus two, equal accuracy.** L. S. Shapley. 9-9-50. Unclassified.

A description of the solution, for the case of all accuracies equal and increasing monotonically from zero to one, of the duel in which the antagonists have one and two silent bullets, respectively. 16 pp. Illus.

- **RM-446 (ATI 210656). On the number of eigenvalues of a certain symmetric kernel.** O. A. Gross and S. S. Walters. 9-5-50. Unclassified.

A proof that a certain integral equation has infinitely many distinct eigenvalues. 7 pp.

- **RM-447 (ATI 210657). On the roots of Markoffian random functions.** A. J. F. Siegert. 9-5-50. Unclassified.

A method of obtaining the spectrum of an observed random function by a study of the distribution of intervals between zero crossings. 20 pp. Illus.

- **RM-448 (ATI 210344). The survival probability problem.** D. A. Darling. 9-8-50. Unclassified.

A critique of the method of Cunningham and Hynd with respect to solving the problem of finding the probability for a target to survive a burst of shots fired from a gun whose aim is a stochastic wandering process. 7 pp.

- **RM-450 (ATI 210658). On functions of the form $\sum_{i=1}^n \varphi_i(x)\psi_i(y)$.** O. A. Gross and S. S. Walters. 9-15-50. Unclassified.

A demonstration of sufficient conditions for a complex valued function, with continuous derivatives of all orders, not to be sum-separable. 6 pp.

- **RM-453 (ATI 210659). Performance effects of double refueling.** J. W. Ellis and W. M. Fromme. 9-15-50. Unclassified.

An extension to the case of double refueling of the methods developed in RM-310, *Performance Effects of Refueling*, which examined the approximate effects of a single outbound refueling on certain performance items. Generalized charts are presented which show how the combat radius, distance to each refueling contact, and target altitude vary with bomb load and landing weight expressed as fractions of the turbine-powered bomber's initial gross weight. 16 pp. Illus.

- **RM-454 (AD 116555). The theory of information.** Edgar Reich. 9-20-50. Unclassified.

A discussion of the modern theory of 2-point unidirectional communication associated with the names of Shannon and Wiener. In addition to outlining Shannon's paper, "A Mathematical Theory of Communication," the memorandum sketches some applications and discusses the question of uniqueness of formulation of the theory of information. 47 pp. Illus.

RM-455 (out of print). The use of mathematical models in the measurement of attitudes. P. F. Lazarsfeld. 3-22-51. Unclassified.

Preliminary findings of a research project on attitude measurements, in which emphasis is placed on the mathematical basis of this approach and its application to empirical materials. 915 pp. Illus.

- **RM-456 (AD 116556). Methodology problems in airframe cost-performance studies.** K. J. Arrow and S. S. Arrow. 9-20-50. Unclassified.

A study of the possible approaches to the problem of establishing a relation between the cost and the performance of airframes which will be useful for such predictive purposes as estimating costs incurred by altered specifications. 33 pp.

- **RM-464. Comments on the modified form of aircraft progress function.** F. S. Hoffman. 10-4-50. Unclassified.

An examination of the aircraft progress curve introduced by the Stanford Research Institute to determine whether this modification shows a clear superiority over the original and simpler form of the curve in terms of the fit of the curves to the observed data. 15 pp.

- **RM-474 (ATI 210345). Noisy duel, one bullet each, with simultaneous fire and unequal worths.** I. L. Glicksberg. 10-16-50. Unclassified.

A consideration of the noisy duel in which the competitors have unequal worths. It is shown that a simple duel of this type has a value but that only one antagonist, in general, has an optimal strategy. 13 pp.

- **RM-477 (ATI 210664). A variable-density spherical-shock-wave problem.** Richard Latter. 10-23-50. Unclassified.

A discussion dealing with the solution of the effect of a varying external density on a shock wave. The problem which is solved in the strong shock approximation for a family of density functions is an important one in studying the propagation of a blast wave. 9 pp.

- **RM-478 (ATI 210665). Minimax theorem for upper and lower semicontinuous payoffs.** I. L. Glicksberg. 10-25-50. Unclassified.

A proof of the minimax theorem for the game played over a pair of compact metric spaces, in which the payoff is an upper or lower semicontinuous function. 4 pp.

- **RM-481 (ATI 210346). Reliability of cost estimates: some evidence.** A. A. Alchian. 10-30-50. Unclassified.

A presentation of data from several sources on the reliability of cost estimates. It is presented as an aid which can be used as a yardstick for gauging the reliability of other cost estimates or predictions. 11 pp.

- **RM-482 (ATI 210666). The evaluation of a definite integral.** R. P. Isaacs. 10-10-50. Unclassified.

A presentation of the method and the results of evaluating a certain definite integral. 14 pp. Illus.

- **RM-484** (out of print). **Equilibrium points in game theory.** P. A. Samuelson. 10-31-50. Unclassified.

A discussion of equilibrium points in n -person games, with a comparison of the Cournot, Stackelberg, and Edgeworth solutions. 7 pp.

- **RM-488** (ATI 210347). **The law of value and Soviet economic planning.** N. M. Kaplan. 11-11-50. Unclassified.

A critical review of the comment in *The American Economic Review* (1944-1945) on a Soviet press release which asserted that, contrary to the views previously held in the Soviet Union, the law of value operates in socialist economics. 30 pp.

- **RM-490** (ATI 210667). **Lagrangian interpolation coefficients and the calculation of maxima and minima and points of inflection.** C. P. Bahrman and F. J. Krieger. 11-1-50. Unclassified.

Expressions for computing the points of maximum and minimum and of inflection for a given set of data having equally spaced arguments obtained from the Lagrangian interpolation formula. Formulas are presented with schemes for simplifying the computations. The methods of computation are illustrated. 13 pp.

- **RM-491** (ATI 210668). **Notes on the game with rational payoff.** I. L. Glicksberg and O. A. Gross. 11-20-50. Unclassified.

Some results on continuous games with rational payoff functions which relate to the existence of step-function solutions. 10 pp. See RM-501.

- **RM-499** (ATI 210669). **On measurable functions K which satisfy $K(x + y) = \sum_{v=1}^n \varphi_v(x) \psi_v(y)$.** I. L. Glicksberg and O. A. Gross. 11-29-50. Unclassified.

A proof that functions which are sum-separable must satisfy certain conditions. 12 pp.

- **RM-501** (ATI 210670). **A class of games with unique density function solutions.** I. L. Glicksberg and O. A. Gross. 11-21-50. Unclassified.

A continuation of RM-491, *Notes on the Game with Rational Payoff*, with an example of a rational game in which the value is rational and yet there is a unique solution which is a pair of density functions. 9 pp.

- **RM-502** (ATI 210671). **Games with positive-density solutions.** Olaf Helmer. 11-21-50. Unclassified.

Proofs of some theorems about games with positive-density solutions, and some examples. 6 pp.

- **RM-504** (ATI 168597). **Behavior of commercial hydrazine in contact with various materials.** Battelle Memorial Institute. 8-1-50. Unclassified.

A presentation of data on the stability and decomposition of commercial hydrazine when exposed to various construction or transportation materials. 21 pp. Illus.

- **RM-510** (ATI 210672). **Continuous games with given strategies.** I. L. Glicksberg and O. A. Gross. 1-3-51. Unclassified.

Two methods of constructing a continuous game with a given pair of distribution functions as a solution. 8 pp.

- **RM-515** (ATI 210379). **German press reaction to the air war in Korea.** Eric Willenz. 1-15-51. Unclassified.

A summary of a pilot study of German press reaction to U.S. air power in Korea. Two communistic and four noncommunistic papers were examined for the summer months of 1950 to ascertain their treatment of a number of themes. 25 pp.

- **RM-517** (ATI 210495). **Expected results of a bombing strike, including reconnaissance.** A. S. Mengel. 1-22-51. Unclassified.

A tabulation of strike-by-strike results of a bombing campaign including reconnaissance (bomb-damage assessment and target verification). The table, which permits expeditious computation, applies to any type of offense or defense aircraft, any practical defense strategy or level, and most practical offense strategies and levels. 89 pp. See RM-522.

RM-519 (ATI 210381) (out of print). **Hydrazine synthesis and dehydration.** Battelle Memorial Institute. 10-1-49. Unclassified.

A summary description of research conducted at the Battelle Memorial Institute from December, 1946, to July 15, 1949, on the synthesis of anhydrous hydrazine for use as a propellant. 200 pp. Illus.

RM-522 (ATI 210494). **Curves giving expected results of a bombing strike.** A. S. Mengel. 1-29-51. Unclassified.

A presentation in graphical form of the tables of expected results of a bombing strike as given in RM-517, *Expected Results of a Bombing Strike Including Reconnaissance*, with an extension in the range of local defense kill potential. 11 pp. Illus.

• RM-524 (ATI 210382). **Working tables of thermodynamic functions and equilibrium constants for silicon, SiO, and SiO₂.** Battelle Memorial Institute. 6-15-50. Unclassified.

Tabulations of the thermodynamic functions and equilibrium constants for silicon, SiO, and SiO₂, essential for the calculation of flame temperatures and gas composition in the combustion of fuels containing silicon. 21 pp. Illus.

• RM-525 (ATI 210675). **RAND REAC manual.** A. S. Mengel and W. S. Melahn. 12-1-50. Unclassified.

A replacement for the Reeves instructions, necessitated by the many modifications of the RAND REAC. Emphasis is placed on the installation of the removable IBM-type plugboard. 189 pp. Illus.

• RM-528 (ATI 210383). **Military doctrine of decision and the von Neumann theory of games.** Col. O. G. Haywood, Jr., USAF. 2-2-51. Unclassified.

An analysis of the military doctrine of command decision in the light of the theory of games. (A student thesis prepared for the Air War College, Maxwell Air Force Base.) 102 pp. Illus.

• RM-534 (ATI 210677). **Moment-space boundaries and some applications.** Melvin Dresher. 2-9-51. Unclassified.

A derivation of the properties of the boundary of the moment space from which is obtained by the mapping method the solution of polynomial-like games. It is shown how these boundaries are used in solving optimal strategies of polynomial games. 13 pp.

• RM-536 (ATI 210678). **Cost-quality relations in bomber airframes.** K. J. Arrow, S. S. Arrow, and H. R. Bradley. 2-6-51. Unclassified.

An attempt to predict the effect that modifications in the quality of performance have on the cost, in direct man-hours, of a bomber airframe. It is assumed that (1) cost is a function of the cumulative unit number produced and the characteristics of the airframe and (2) the percentage of labor off-site is a possible explanatory variable. 41 pp. Tables.

• RM-538 (ATI 210679). **A class of games with unique solutions.** I. L. Glicksberg and O. A. Gross. 2-12-51. Unclassified.

An illustration of the fact that in a game with payoff $M(x, y) = \varphi(x, y) + \rho(x) + \tau(y)$ played over the unit square, if either player has non-step-function optimal strategy, the opposing player has a unique optimal strategy. Examples are included which show that games with well-behaved payoffs can have unique solutions which are more or less pathological. 7 pp.

• RM-539 (ATI 210680). **The choice among investment alternatives in Soviet theory.** N. M. Kaplan. 2-8-51. Unclassified.

An examination of the views of Soviet economists on a criterion for choice among investment alternatives, given the rate of investment. An evaluation of the fundamental agreement of the groups examined with the "bourgeois" concept of the rate of interest. 95 pp. A revision of P-177.

• RM-540 (out of print). **Notes on the dynamic approach to saddle-points and extremum points; gradient methods and the equations of classical mechanics.** P. A. Samuelson. 2-12-51. Unclassified.

A study of the problem of devising efficient difference-equation sequences of successive approximation for locating the position of the saddle-point in the solution of certain maximum problems in economics and linear programming. 24 pp. Illus.

- **RM-544** (out of print). A translation of the Simon employment relationship theory into the Kruskal-Newell language. W. Keen, Comdr., USN. 12-29-50. Unclassified.

A test of the idea that the Kruskal-Newell language of organization theory has sufficient generality to permit description in this language of the essential features of some specific model of organization originally described in another tongue. The model selected for test is that of H. A. Simon for employment relationships and comparison of the theory of the firm with the theory of information. 8 pp.

- **RM-549** (ATI 210684). The pathological nature of certain games with rational payoff. I. L. Glicksberg and O. A. Gross. 3-2-51. Unclassified.

A construction of an example of a continuous game with rational payoff in which the unique optimal strategy for one player has a countable set of jumps, the jumps occurring at a dense set of points. The example would seem to shatter the view that games with rational payoffs can be solved by methods similar to those used in polynomial games. 8 pp. See supplement RM-568.

- **RM-555** (AD 116562). The capacity of a railroad freight yard (a survey of the problem—not a solution). Allen Newell. 6-14-50. Unclassified.

A study of the ability of a railroad freight yard to receive, hold, and deliver freight cars upon order. 17 pp. Illus.

- **RM-563** (ATI 210689). Estimating output from floor space: feasibility. A. Alchian, A. Skogstad, and N. Hanunian. 3-13-51. Unclassified.

A discussion of estimating airframe output from any given plant. Only the airframe type and weight, the floor area of the plant, and the date on which the plant initiated production of the specified model are known. 16 pp.

- **RM-566** (out of print). National economic accounts of the USSR in 1944: preliminary report. A. Bergson and H. Heymann, Jr. 3-15-51. Unclassified.

A summary of calculations on the sources and disposition of incomes in the USSR in 1944. This study is part of a larger investigation of the national economic accounts of the USSR for a number of years. 77 pp. Illus. Incorporated in R-253, *Soviet National Income and Product, 1940-48*, published by the Columbia University Press, New York, 1954. \$5.00.

- **RM-568** (ATI 210691). The pathological nature of certain games with rational payoff—II. I. L. Glicksberg and O. A. Gross. 3-23-51. Unclassified.

A construction of an example of a continuous game with rational payoff in which the unique optimal strategy for each player has a countable set of jumps, the jumps occurring at a dense set of points. 5 pp. A continuation of RM-549.

- **RM-569** (ATI 210692). Some useful passages from Lenin and Stalin. N. C. Leites. 3-20-51. Unclassified.

A collection of statements from Lenin and Stalin which condemn the "iron curtain" policy and current propaganda of the present Politburo. In addition, Soviet defeat in a war with the free world is predicted and the American Revolution approved. 13 pp.

RM-575 (ATI 121383). Conversion of interceptor design parameters and cost to air battle parameters for a 1954-1958 air battle analysis. W. B. Dennis. 5-4-51. Unclassified.

An examination of the methods for converting interceptor design parameters and cost into the form required for use in the air battle studies. This study in the Air Battle Analysis series considers off-design capabilities of the interceptors in combat and the determination of the fighter-bomber ratio in combat. 38 pp. Illus.

- **RM-593** (ATI 210695). Density of games with unique solutions. I. L. Glicksberg and O. A. Gross. 4-16-51. Unclassified.

A proof that the set of continuous games (played over the unit square) with unique solutions is dense in the space of all games with continuous payoffs. 7 pp.

- **RM-594 (ATI 210696). The Combomat: customer-programmed IBM calculation.** Numerical Analysis, Mathematics Division. 1-30-51. Unclassified.

A description of a setup which makes it possible for the customer to program his problem directly for IBM machinery, thereby expediting the computation. 21 pp. Illus. See condensed version P-216.

- **RM-595 (ATI 210697). Machine method: iterative solution of games.** R. W. Bemer. 2-26-51. Unclassified.

A description of a machine method for the iterative solution of games. 12 pp. Illus.

- **RM-596. Matrix multiplication using standard IBM equipment.** Jean Hall. 2-27-51. Unclassified.

A description of a routine for matrix multiplication using standard IBM equipment. 4 pp.

- **RM-597. Games with circular symmetry.** L. J. Savage. 8-27-48. Unclassified.

A characterization of the effective strategies of a game with circular symmetry. 3 pp.

- **RM-598 (ATI 210698). Preliminary investigation of a prestressed ceramic wing.** F. R. Shanley. 1-24-51. Unclassified.

A discussion of a hypothetical wing design, in which the primary structure is composed of a light-weight ceramic material precompressed by means of spanwise tension wires. The weight of such a structure is found to compare favorably with other methods of construction previously investigated for operation at high temperatures. The principles of prestressing are developed from the design point of view and recommendations are made as to the most efficient methods of design. 25 pp. Illus.

- **RM-605 (out of print). Weight analysis of thick-plate wing structures.** F. R. Shanley. 2-1-51. Unclassified.

An analysis of wing weight equations for the type of wing structure consisting primarily of two thick plates separated by spanwise webs or equivalent stiffening material. 18 pp. Illus. Published in *Weight-Strength Analysis of Aircraft Structures* (out of print), McGraw-Hill Book Company, Inc., New York, 1952. \$8.50.

- **RM-608 (ATI 210702). Factorable games.** Olaf Helmer. 5-4-51. Unclassified.

A discussion of two cases of finite games where the matrix is decomposed into submatrices and the solution can be found by solving the games represented by some of these submatrices. 5 pp.

- **RM-610 (ATI 210703). Moments of the distribution of outcomes of a game.** I. L. Glicksberg and O. A. Gross. 5-11-51. Unclassified.

A derivation of the moments of the outcome distribution of a continuous game over the unit square with continuous payoff. 1 p.

- **RM-611 (ATI 210704). A game with respective optimal spectra of cardinality c and 1.** I. L. Glicksberg and O. A. Gross. 5-15-51. Unclassified.

A presentation of a counter-example to the conjecture that if either player in a game over the unit square with continuous payoff has a step-function optimal strategy, then the same is true of his opponent. 3 pp.

- **RM-612 (ATI 210386). Radius extension effects of refueling a bomber by dissimilar tankers.** C. V. Sturdevant III. 5-29-51. Rev. 5-9-52. Unclassified.

An investigation of the effects on range of refueling in flight. It is assumed that (1) the characteristics of the bombers and tankers are known and (2) the tankers are identical to each other and have cruising speeds different from those of the bombers. 51 pp. Illus.

- **RM-614 (AD 116563). Note on the formulation of the study of logistics.** Oskar Morgenstern. 5-28-51. Unclassified.

An attempt to outline a consistent language and more adequate empirical descriptions in formulating a logistics theory. The logical situation and problem are examined. In addition, the similarity between military and business logistics is discussed. 13 pp.

- **RM-615 (ATI 210706). n -Person games: an example and a proof.** J. F. Nash. 6-4-51. Unclassified.

A presentation of a duopoly example and a brief proof of the existence of equilibrium points yielding a simple proof of the main theorem of 2-person zero-sum games. 3 pp.

- **RM-617 (AD 116564). What is a sensitivity analysis?** E. F. Beckenbach and S. M. Johnson. 5-9-51. Unclassified.

A tentative definition of sensitivity analysis and a discussion of certain advantages and applications of such analyses. 6 pp.

- **RM-618 (ATI 210707). A simple maximization problem.** J. M. Danskin, Jr. 5-29-51. Unclassified.

A routine solution of a maximization problem, that of maximizing a certain integral under given constraints. 8 pp.

- **RM-619 (AD 116565). Formulating precise concepts in organization theory.** A. Newell and J. B. Kruskal, Jr. 6-1-51. Unclassified.

Definitions of organizational concepts, using the concepts of the algebra of sets and the calculus of relations and the usual concepts of mathematics. 14 pp.

- **RM-620 (ATI 210708). Continuous games with given unique solutions.** I. L. Glicksberg and O. A. Gross. 6-6-51. Unclassified.

A demonstration that given a pair of distributions over the unit interval, (f, g) , there exists a game (with continuous payoff) over the unit square with the unique solution (f, g) . 8 pp.

- **RM-635 (ATI 210709). Hours of darkness at altitude.** A. S. Mengel. 6-19-51. Unclassified.

A derivation of an equation giving the hours of darkness as a function of altitude, latitude, declination of the sun, and degree of darkness. 15 pp. Illus.

- **RM-638 (ATI 210710). On determining the full set of solutions of a finite game.** L. S. Shapley. 6-27-51. Unclassified.

A detailed account of a procedure for establishing whether a given set of solutions to a finite game is complete. 11 pp.

- **RM-641 (ATI 210387). The noisy duel: existence of a value in the singular case.** L. S. Shapley. 7-6-51. Unclassified.

A presentation of a simple example and a formal method of solving an indeterminate duel, with a characterization of the formal solution as the limit of an iterative process that is intuitively plausible. 16 pp. Illus.

- **RM-644. Extracting roots of polynomial equations.** I. D. Greenwald. 7-9-51. Unclassified.

A description of an iterative scheme for extracting roots of polynomial equations. 3 pp.

- **RM-645 (ATI 210711). On a geometrical game connected with sequential analysis.** R. E. Bellman. 7-11-51. Unclassified.

A consideration of a game which has its origins in some strategic bombing models. 12 pp. Illus.

- **RM-646 (ATI 166938). The viscosity of polar gases.** F. J. Krieger. 7-1-51. Unclassified.

The coefficients of viscosity for several polar gases and vapor are computed for temperatures up to 3000°K and at a nominal pressure of 1 atm. 20 pp. Illus.

- **RM-647 (ATI 210712). On a general class of problems involving sequential analysis.** R. E. Bellman. 7-16-51. Unclassified.

A discussion of a general class of multistage problems occurring in fields such as strategic bombing, transportation routing, and information testing. 6 pp.

- **RM-648 (AD 116566). On a transportation problem.** R. E. Bellman. 7-16-51. Unclassified.

A presentation of a method of solution of the problem of routing a given number of ships and cargoes among three ports so as to accomplish the required shipping in a minimum time. 4 pp.

- RM-649 (ATI 166939). Calculation of the viscosity of gas mixtures.** F. J. Krieger. 7-13-51. Unclassified.

A presentation of two semiempirical general equations for the viscosity of a mixture of n gaseous components. Tables of viscosities and coefficients of diffusion are given for several gases commonly found as products of combustion for temperatures up to 5000°K and at atmospheric pressure. 11 pp. Illus.

- **RM-651 (ATI 210713). On a problem in the theory of testing.** R. E. Bellman. 7-20-51. Unclassified.

A discussion of a problem encountered in the theory of testing. Given that a system is in one of a finite number of states, there is the problem of determining the state as rapidly as possible. 8 pp.

- **RM-654 (ATI 210714). Sums of games.** J. W. Milnor. 7-27-51. Unclassified.

A demonstration that a certain class of two-person zero-sum perfect information games, without chance moves, form a group under a suitable composition law. 6 pp.

- **RM-655 (ATI 210715). Games concave on each side of the unit square diagonal.** I. L. Glicksberg and O. A. Gross. 7-25-51. Unclassified.

A derivation of a simple relationship between the spectra of optimal strategies for a certain class of games with continuous payoff. 9 pp.

- **RM-656 (ATI 210716). Notes on the n -person game—I: characteristic-point solutions of the four-person game.** L. S. Shapley. 7-25-51. Unclassified.

A presentation of a family of solutions, covering all zero-sum four-person games, which behave continuously under perturbation of the characteristic function. 14 pp. Illus. See RM-670, RM-817, RM-881, and RM-1005.

- **RM-657. Use of the special program device on the 417 tabulator.** Bruno Chiappinelli. 7-26-51. Unclassified.

A description of the expansion of total programs from three to twenty-eight on the IBM 417 tabulator by use of the special program device. 4 pp. Illus.

- **RM-660 (ATI 210608). Tables in brief: mathematical tables for use with desk calculators.** W. B. White. June 1951. Unclassified.

A compact source of tabular mathematical data for the use of computers who have occasional rather than constant need of the individual tables. 38 pp. Illus.

- **RM-670 (ATI 210720). Notes on the n -person game—II: the value of an n -person game.** L. S. Shapley. 8-21-51. Unclassified.

A deduction of a "value" for the essential n -person game and the establishment of a number of sample properties of the value. 17 pp. Illus. See RM-656, RM-817, RM-881, and RM-1005.

- **RM-671. Neural nets for "Toad T1."** A. S. Householder. 8-23-51. Unclassified.

A description of a nervous system which is capable of controlling behavior of the type exhibited by "Toad T1" and which is constructed of Randons which operate like McCulloch-Pitts neurons. 9 pp. Illus.

- **RM-673 (ATI 156399). Flight test of ASR-1 radar at low altitudes.** J. F. Digby. 8-30-51. Unclassified.

A study of flight tests of the CAA Airport Surveillance Radar, ASR-1, indicating the maximum range in the 200-ft, 500- to 1,000-ft and 10,000-ft altitude brackets. 8 pp. Illus.

- **RM-674. Note on the problem of aggregation.** K. J. Arrow, E. W. Barankin, and R. W. Shephard. 8-28-51. Unclassified.

A restatement of the problem of aggregation for cost and production function of a single process and an application of the condition for attainment of rather general sufficient conditions under which this problem may be solved. 9 pp.

- **RM-675 (ATI 210612). Axioms for measurable utility.** J. W. Milnor. 8-28-51. Unclassified.

A proof that two different sets of axioms imply the existence of a von Neumann-Morgenstern utility. 4 pp.

- **RM-676 (ATI 210613). Lagrange multipliers revisited (a contribution to nonlinear programming).** Cowles Commission. August 1951. Unclassified.

A discussion of a generalization of the work by Kuhn and Tucker on the transformation of a certain class of constrained maximum problems into equivalent saddle value (minimax) problems. 12 pp.

- **RM-677 (ATI 210721). The determination of decision regions for a simplified two-plane bombing model.** H. N. Shapiro. 9-4-51. Unclassified.

A consideration of a simplified two-plane bombing model, with a presentation of a purely arithmetic determination of the decision regions. 17 pp.

- **RM-678 (ATI 210614). Some notes for simple Pavlovian learning.** A. S. Householder. 9-10-51. Unclassified.

A representation of some neural nets capable of mediating simple Pavlovian reflexes in their qualitative features, and some suggestions for further elaboration. 7 pp. Illus.

- **RM-679 (ATI 210615). Games against nature.** J. W. Milnor. 9-4-51. Unclassified.

An axiomatic study of various criteria for playing games against Nature; and a discussion of the concept of an equilibrium point for n -person games against Nature. 23 pp. Illus.

- **RM-684 (ATI 210616). Decision functions for bombing models.** Melvin Hausner. 9-11-51. Unclassified.

A definition of a function corresponding to any bombing model. This is a decision function for a class of bombing models; in models where decision functions are unknown, it is suggested that this function be taken as a first guess. 4 pp.

- **RM-686 (ATI 210723). A stochastic development of "Ballantyne's integral equation."** R. P. Peterson. 9-11-51. Unclassified.

A derivation of the integral equation of Ballantyne from a Markovian stochastic model. 3 pp.

- **RM-688 (out of print). A bibliography of the theory and application of differential-difference, renewal, and related functional equations.** R. E. Bellman, J. M. Danskin, Jr., and I. L. Glicksberg. 9-14-51. Unclassified.

A separate bibliography which was compiled in the course of preparing a survey of the theory and application of differential-difference, renewal, and related functional equations. 13 pp. Superseded by R-256 (out of print).

- **RM-689 (ATI 210724). Empirical determination of noise spectra.** A. J. F. Siegert. 10-14-51. Unclassified.

A computation of the error incurred in obtaining the spectrum of a stationary Gaussian random function from a sample of finite length. 11 pp.

- **RM-690 (ATI 210388). An inventory problem: the bankruptcy question.** D. A. Darling. 9-20-51. Unclassified.

A treatment of an inventory problem, using the methods of stochastic processes. 9 pp.

- **RM-693 (ATI 210389). Some remarks on the double description method.** E. H. Jacobs, R. M. Thrall, and R. A. Wagner. 7-28-52. Unclassified.

An application of the double description method to games with linear constraints on the strategy space of one or both players. In addition, an adaptation of the method for use with IBM equipment is described. 21 pp. Illus.

- **RM-697 (ATI 210391). An embedding of a mixture space in a vector space.** Melvin Hausner. 10-4-51. Unclassified.

A short proof that any mixture space is a subspace of a vector space over the real numbers. 11 pp.

- **RM-698 (ATI 210392). An embedding of a utility space in an ordered vector space.** M. Hausner and J. G. Wendel. 10-4-51. Unclassified.

A demonstration that any utility space may be embedded in an ordered vector space where p -mixtures correspond to convex combination and order is preserved. 4 pp.

- **RM-702 (AD 107434). The axial pressure force on an inclined body of revolution in supersonic flow.** M. D. Van Dyke. October 1951. Unclassified.

Hybrid theory results for axial pressure force coefficients at angle of attack are given for a few cones and the A-4 ogive at supersonic speeds. Comparison is also made with first-order theory and with wind-tunnel data. 8 pp. Illus.

- **RM-703 (ATI 210393). Distribution of USSR nonagricultural employment, 1928-1950: a preliminary study.** A. D. Redding. 10-18-51. Unclassified.

Estimates of USSR nonagricultural employment by broad sectors of the economy from 1928 to 1941 and by individual industries from 1928 to 1937. Summary data for later years are also shown. These estimates are compared with similar data for the United States. 18 pp. Illus.

- **RM-704 (ATI 210394). Representation of events in nerve nets and finite automata.** S. C. Kleene. 12-15-51. Unclassified.

An elementary exposition of the problems and results obtained during investigations in August, 1951, of the kinds of events any finite automaton can respond to by assuming one of certain states. 98 pp. Illus.

- **RM-705 (ATI 210395). A game value characterization of algebraic numbers.** O. A. Gross. 10-29-51. Unclassified.

A proof that a necessary and sufficient condition for a real number to be the value of a polynomial game over the unit square, with only integral coefficients in the payoff, is that it be an algebraic number. 7 pp.

- **RM-706 (ATI 210396). A note on payoffs which vanish almost everywhere.** O. A. Gross. 10-29-51. Unclassified.

A proof that one can find a game over the unit square whose payoff vanishes almost everywhere, such that a given distribution function over the closed unit interval is the unique optimal strategy for one of the players. 4 pp.

- **RM-707-1. Retail food prices in the USSR, 1937-1948.** J. G. Chapman. 1-13-53. Unclassified.

An attempt to measure the change in retail food prices in the USSR between 1937 and 1948. This index, based on Moscow prices, relates to official food prices in state and cooperative stores and restaurants, but does not cover prices on the free collective farm market. 117 pp. Illus. See also RM-1294.

- **RM-709 (ATI 210397). Report of a seminar on organization science.** M. M. Flood (ed.). 10-29-51. Unclassified.

Several talks presented at a seminar held in Santa Monica, California (August, 1951), to discuss current RAND research on organization problems. 55 pp. Illus. See P-256, P-258, P-263, P-312, P-346, and RM-789-1.

- **RM-712 (ATI 210399). Separation theorems for convex bodies.** Melvin Hausner. 10-31-51. Unclassified.

A presentation of some new proofs of separation theorems for convex sets, with their generalization to the infinite-dimensional case. The method involves simply ordered vector spaces. 6 pp.

- **RM-713 (ATI 210727). Ratio of crew to aircraft requirements as affected by attrition.** C. V. Sturdevant III. 10-30-51. Unclassified.

A study to determine how attrition affects the number of crews required for the operation of a given number of aircraft, taking into consideration tour of duty and survival probability. 10 pp. Illus.

- **RM-718 (ATI 210400). An infinite-dimensional extension of a symmetric Blotto game.** O. A. Gross. 11-8-51. Unclassified.

A consideration of a two-person zero-sum game over a function space and with discontinuous payoff, which has an optimal strategy for either player, consisting of randomizing over a certain two-parameter family of functions. 6 pp. Illus.

- **RM-721 (ATI 210402). Short proof of a theorem of Gross.** J. G. Wendel. 11-9-51. Unclassified.

A new proof that two distributions whose moments alternate are identical. 2 pp.

- **RM-724 (ATI 210403). A generalization of numerical utilities.** R. M. Thrall and N. C. Dalkey. 11-16-51. Unclassified.

A generalization of the von Neumann-Morgenstern theory of utility, with applications to decision-making and game theory. 30 pp.

- RM-727 (ATI 210730). The use of experts for the estimation of bombing requirements: a Project Delphi experiment.** N. C. Dalkey and O. Helmer. 11-14-51. Unclassified.

A report on a recent experiment in the use of experts for the estimation of bombing requirements against U.S. industrial targets. This experiment is one in a series performed at RAND, designated internally as "Project Delphi." 33 pp. Illus.

- RM-730 (AD 116567). Time, equipment, and costs to repair cratered runways.** J. J. O'Sullivan. 11-27-51. Unclassified.

Part of a larger study on strategic air base systems which examines the cost of repairing craters of varying sizes. Several levels of facilities for repair are considered, together with multiple and single cratered runways. In addition, the time for operating and assembling the machinery is discussed. 32 pp. Illus.

- **RM-734 (ATI 210734). Prolegomena to a theory of organization.** Oskar Morgenstern. 12-10-51. Unclassified.

A discussion of a framework within which to make initial descriptive analyses of organizations, the framework dealing solely with the centrally directed organizations. 122 pp. Illus.

- **RM-735 (ATI 210431). Capital investments in the Soviet Union, 1924-1951.** N. M. Kaplan. 11-28-51. Unclassified.

The first of several studies on Soviet capital formation which discusses investment flows (expressed in current rubles). The conceptual and organizational aspects of Soviet capital formation which are prerequisite for interpreting Soviet data are considered, together with basic data on annual investments. 218 pp. Illus.

- **RM-736 (ATI 210432). Continuous Blotto.** M. P. Peisakoff. 12-4-51. Unclassified.

A presentation of the value and one-parameter continuous optimal strategies for a continuous Blotto game. 6 pp. Illus.

- **RM-737 (ATI 210433). Note on games over a function space with homogeneous kernels.** W. H. Fleming. 11-30-51. Unclassified.

A proof that certain games with functions defined on the closed unit interval $(0, 1)$ as pure strategies, and payoffs which involve a homogeneous kernel and a function assigning various weights to points of $(0, 1)$ can be reduced to games of the same type in which every point of $(0, 1)$ is weighted equally in the payoff. 3 pp.

- **RM-744 (ATI 210434). Flicker and fusion in a hypothetical device for light-intensity discrimination.** J. T. Culbertson. 1-1-52. Unclassified

A description of a nerve net which acts as a brightness indicator. It is then shown how flicker or fusion results (under periodic intermittent illumination), depending on intensity, frequency, and some other factors. 22 pp. Illus.

- **RM-745 (ATI 210435).** On weak convergence of strategies in certain games over a function space. W. H. Fleming. 12-17-51. Unclassified.

A proof that, for a certain class of games over a function space, mixed strategies are weak limits of pure strategies. 8 pp.

- **RM-747 (ATI 210436).** Two examples concerning behavior strategies. F. B. Thompson and R. A. Wagner. 12-18-51. Unclassified.

A discussion of two examples by means of which some questions concerning properties of behavior strategies in finite games are answered. 8 pp. Illus.

- **RM-748 (AD 116568).** Phase coherence of reflections from scatterers. Edgar Reich. 12-18-51. Unclassified.

A study of the calculation of the phase difference to be expected between successive reflections of an incident sine wave from a moving target. 9 pp. Illus.

- **RM-752 (ATI 210437).** A second note on payoffs which vanish almost everywhere. O. A. Gross. 1-10-52. Unclassified.

A proof that, given a pair (f, g) of distribution functions over $[0, 1]$, there is a game over the square with payoff vanishing almost everywhere which has (f, g) as its unique solution. 3 pp.

- **RM-753 (AD 101882).** A statistical theory of target detection by pulsed radar: mathematical appendix. J. I. Marcum. 7-1-48. Unclassified.

A mathematical supplement to RM-754, *A Statistical Theory of Target Detection by Pulsed Radar*. In addition, the present study discusses (1) collapsing, limiting, and antenna beam shape loss, (2) the effect of signal injection, and (3) moving-target indication. 113 pp. Illus. See also RM-1008, RM-1217, and RM-1719.

- **RM-754 (AD 101287).** A statistical theory of target detection by pulsed radar. J. I. Marcum. 12-1-47. Rev. 4-25-52. Unclassified.

A study to obtain the probability that a pulsed-type radar system will detect a given target at any range. The mathematical appendix is published as RM-753, *A Statistical Theory of Target Detection by Pulsed Radar: Mathematical Appendix*. 81 pp. Illus. See also RM-1008, RM-1217, and RM-1719.

- **RM-759 (ATI 210438).** Equivalence of games in extensive form. F. B. Thompson. 1-4-52. Unclassified.

A characterization of four simple transformations which are sufficient to carry any two equivalent games in extensive form one into the other. Application is made to the problem of simplification of a game in extensive form. 12 pp. Illus.

- **RM-763 (AD 107351).** A simple method for calculating the thrust of turbojet engines with underexpanded, convergent exhaust nozzles. L. R. Woodworth. 1-11-52. Unclassified.

A simplified method of computation for determining jet thrust when variable-area, converging nozzles are employed and when the jet pressure-ratio exceeds the critical value. 10 pp. Illus.

- **RM-766 (ATI 210501).** Estimation of Bremsstrahlung radiation from Ce^{144} power-plant. S. T. Cohen. 6-10-49. Unclassified.

Calculations to determine the magnitude of the effect of Bremsstrahlung radiation from a proposed nuclear powerplant using Ce^{144} . An upper bound on the radiation intensity has been assumed. 17 pp. Illus.

- **RM-767.** Prices of ordinary rolled steel in the Soviet Union, 1928-1950. A. Bergson and E. L. Turgeon. 1-21-52. Unclassified.

A discussion of the changes in wholesale rolled-steel prices in the USSR from 1928-1950. This is part of a larger study which is concerned with wholesale prices generally and may ultimately provide a basis for the calculation of various deflators for components of Soviet national income data expressed in current rubles. 89 pp. Tables. See also RM-778 and RM-802.

- **RM-769 (ATI 210439). Behavior strategies in finite games.** F. B. Thompson. 1-22-52. Unclassified.

A development of the relation between behavior strategies and mixed strategies with a characterization of those game structures solvable by behavior strategies. 17 pp. Illus.

- **RM-770 (ATI 210440). A hypersonic approximation of the pressure forces on ogives.** G. B. W. Young and J. H. Huntzicker. 1-24-52. Unclassified.

An application of the methods of hypersonic approximation to ogives at angle of attack. These pressure determinations are of fundamental importance to missile drag considerations as well as structural design and materials studies. 22 pp. Illus.

- **RM-776 (ATI 210441). Games of survival.** Melvin Hausner. 2-12-52. Unclassified.

A proof that in general a 2×2 zero-sum game of survival has a solution. It is shown that the two motives, of survival or of ruin of the opponent, are equivalent. 7 pp.

- **RM-777 (ATI 210442). Optimal strategies in games of survival.** Melvin Hausner. 2-18-52. Unclassified.

A presentation of a simple procedure for calculating the optimal strategies and the survival probability for a general class of games of survival. 5 pp.

- **RM-778. Prices of quality rolled steel in the Soviet Union, 1928–1950.** A. Bergson and E. L. Turgeon. 2-8-52. Unclassified.

A supplement to RM-767, *Prices of Ordinary Rolled Steel in the Soviet Union, 1928–1950*. 67 pp. Tables. See also RM-802.

- **RM-780 (ATI 210443). A preference experiment.** M. M. Flood. 2-25-52. Unclassified.

An investigation to determine if a set of objects can have exactly the same monetary value but differ widely and inconsistently in personal utilities attached to them by subjects. Thirteen subjects made sealed bids on twenty-four objects, each object being a chance at stated odds at a specified sum of money. 14 pp. Illus.

RM-787 (AD 116569). A simplified study of reconnaissance in strategic bombing campaigns. H. Kahn and A. W. Marshall. 3-6-52. Unclassified.

A preliminary investigation which evaluates poststrike reconnaissance in a strategic bombing campaign by means of Markoff matrices. This study may be useful in determining the effects of alternative reconnaissance strategies upon the cost of carrying out strategic bombing operations. 34 pp. Illus.

- **RM-788 (ATI 210741). Political vulnerability of Moscow: a case study of the October, 1941, attack.** L. Gouré and H. S. Dinerstein. 4-21-52. Unclassified.

An attempt to describe how the Soviet central administration and the population of Moscow reacted to the almost-successful German attack on the city in the fall of 1941. 128 pp. See also RM-2075. Published as *Two Studies in Soviet Controls: Communism and the Russian Peasant; Moscow in Crisis*, The Free Press, Glencoe, Illinois, 1955. \$4.50.

- **RM-789-1 (ATI 210444). Some experimental games.** M. M. Flood. 6-20-52. Unclassified.

A study of several experimental games to test the applicability and usefulness of the axiomatic structures developed by von Neumann, Morgenstern, and others. 44 pp. Illus. See also P-256, P-258, P-263, P-312, P-346, and RM-709.

- **RM-791 (ATI 210445). A pursuit game with incomplete information.** R. P. Isaacs. 3-11-52. Unclassified.

An analysis of a simple, nontrivial example of a pursuit game lacking full information. 28 pp. Illus.

- **RM-793-1 (AD 98443). Infrared radiation from celestial bodies.** L. E. Larmore. 3-17-52. Rev. 6-26-52. Unclassified.

An attempt to determine the number and distribution of celestial objects which may be expected to give infrared radiation of sufficient intensity to act as disturbing factors interfering with the detection of distant targets. 21 pp. Illus.

- **RM-794 (ATI 210743). Bacteria.** Humbert Morris. 3-19-52. Unclassified.

An elementary discussion of the structure and life processes of bacteria. This study may be useful for indoctrination purposes in studying bacteriological warfare. 34 pp. Illus.

- RM-797 (ATI 156404). Desirability of in-the-air overloading of aircraft.** C. V. Sturdevant III. 3-21-52. Unclassified.

A discussion of the desirability of in-the-air overloading with fuel based on considerations of radius extension only. Specifically, the study considers (1) in-the-air overloading over home base; (2) in-the-air overloading of aircraft which are designed for use in a refueled operation, the refueling taking place at the distance which results in maximum radius extension of the refueled aircraft; (3) a specific example for a typical high-performance aircraft; and (4) the effects, on required tanker size, of overloading over home base (as compared with no overloading) for constant radius. 17 pp. Illus.

- **RM-802 (ATI 210411). Prices of iron and steel products in the Soviet Union, 1928–1950: a summary report.** A. Bergson and E. L. Turgeon. 3-26-52. Unclassified.

An extension of RM-767, *Prices of Ordinary Rolled Steel in the Soviet Union, 1928–1950*, and RM-778, *Prices of Quality Rolled Steel in the Soviet Union, 1928–1950*. The present study computes index numbers for the iron and steel industry generally (including ordinary and quality rolled steel and castings). 14 pp. Illus.

- **RM-803-1 (ATI 210412). Retail prices of manufactured consumer goods in the USSR, 1937–1948.** J. G. Chapman. 12-12-52. Unclassified.

An index of the change in retail prices of manufactured goods in the USSR between 1937 and 1948. This index, together with the one of Soviet retail food prices presented in RM-707-1, *Retail Food Prices in the USSR, 1937–1948*, provides a basis for comparing the volume of retail sales in 1937 and 1948 in "real" terms. 120 pp. Illus.

- **RM-804 (ATI 210413). A dollar index of Soviet petroleum output, 1927–28 to 1937.** A Gerschenkron and A. E. Nimitz. 4-4-52. Unclassified.

A continuation of R-197, *A Dollar Index of Soviet Machinery Output* (out of print). The present study attempts to measure the Soviet output of petroleum products during 1927/28–1937. U.S. dollars of 1939 purchasing power are used as the unit of measurement. 210 pp. Illus. See also RM-1042 and RM-1055.

- RM-810 (AD 108421). Expected damage from one bomb to a circular ring.** W. H. Fleming. 4-17-52. Unclassified.

A development of mathematical formulas to describe expected damage and optimum aim points for one bomb against a target distributed uniformly around the circumference of a circle. 12 pp. Illus.

- **RM-814 (ATI 210414). Minmax theorem for a class of games over a function space.** W. H. Fleming. 4-17-52. Unclassified.

A demonstration of the existence of a value and optimal mixed strategies for certain two-person games played over a space of bounded measurable functions. 18 pp.

- **RM-815-1 (ATI 168594). Population of major cities of the USSR.** Theodore Shabad. 6-10-52. Unclassified.

Lists of USSR cities with estimated 1950 populations. A discussion of methodology is presented, followed by (1) a basic list, alphabetically arranged and containing such data as population estimate, margin of error, and administrative location, and (2) a supplementary list, arranged by size groups. 25 pp.

- **RM-817 (ATI 210415). Notes on the n -person game—III: some variants of the von Neumann-Morgenstern definition of solution.** L. S. Shapley. 4-22-52. Unclassified.

An introduction of the concept of "G-stability," from which several new definitions of "solution" are obtained. Some theorems are proved, and a number of examples are given. 10 pp. Illus. See RM-656, RM-670, RM-881, and RM-1005.

- **RM-818 (ATI 210416).** Another proof of the minmax theorem for continuous pay-offs. J. M. Danskin, Jr. 4-8-52. Unclassified.

The convergence for continuous games of the Brown-Robinson iterative process is used to prove the minmax theorem for these games. 3 pp.

- **RM-819 (ATI 210417).** Shock wave interaction, or the velocity effect in H.E. rounds. B. W. Augenstein. 4-15-52. Unclassified.

Calculations to determine whether pressure increases of an interesting magnitude can arise when an idealized blast interacts with an idealized head wave of a projectile. 7 pp. Illus.

- **RM-821-6 (out of print).** Selected list of unclassified publications of the Economics Division of The RAND Corporation. Economics Division. Revised periodically. Unclassified.

Superseded by RM-2800-PR.

- **RM-838 (AD 107263).** Tabulated results of hot gas generator cycle calculations. C. C. Kelber and L. R. Woodworth. 5-2-52. Unclassified.

Data intended to reduce the calculation effort required in preliminary design and performance prediction of aircraft gas turbine powerplants. The results of numerous cycle calculations are tabulated for hot-gas generators operating on the (air plus combustion products) Joule or Brayton cycle. 71 pp. Illus.

- **RM-841 (ATI 166940).** Physical properties of the upper atmosphere. H. K. Kallmann. 5-12-52. Unclassified.

Tables which give values for the physical properties of the upper atmosphere from sea level up to 250 km which are most likely to be encountered under normal conditions at the corresponding altitudes given. 19 pp. Illus.

RM-842. A study of homogeneous H_2O , D_2O , U^{235} reactors with a note on optimum moderating mixtures for a minimum U^{235} requirement. George Safonov. 5-1-52. Unclassified.

An application of the multigroup equations of Appendix II, R-233, *Notes on Multigroup Techniques for the Investigation of Neutron Diffusion* (out of print), to a study of bare homogeneous reactors containing H_2O , D_2O , and U^{235} . 11 pp. Illus.

- **RM-844 (ATI 162005).** Axial and normal force coefficients for pointed bodies of revolution at super- and hypersonic speeds—part I: noses and cylinders. J. H. Huth and H. M. Dye. 5-21-52. Unclassified.

Drag and lift data are presented for a selected group of ogival noses with cylindrical afterbodies in a Mach number range extending from approximately 1.5 to infinity. Comparisons are also made with the inscribed cones at corresponding Mach numbers. This study serves as an aid to the aerodynamicist in optimizing missile design. 16 pp. Illus. See Part II, RM-905.

- **RM-848 (ATI 162006).** Note on directional effects of pressure field of moving blast. J. D. Cole. 6-9-52. Unclassified.

A study of the interaction of the pressure field of the moving body and the explosion to determine the possible directional effect of blast. Linearized (acoustic) equations are derived, and various idealizations are made. 14 pp. Illus.

- **RM-856-1 (ATI 210418).** Proof of a theorem of Hayes on the location of the roots of a certain entire transcendental function. J. M. Danskin, Jr. 9-11-52. Unclassified.

A demonstration of a theorem of N. D. Hayes, giving a necessary and sufficient condition that the roots of a certain transcendental entire function should all have their real parts negative. The present study shows how to obtain Hayes' result more easily from the result of a paper of Pontrjagin. 8 pp.

- **RM-857 (ATI 210419). A model for partial damage to point targets.** M. R. Mickey, Jr. 6-2-52. Unclassified.

A discussion of a model for studying partial damage to point targets from independent bomb drops. Tables are provided for computing the mean and variance of the damage for a particular case. 8 pp. Illus.

- **RM-858 (ATI 210420). Remark on a theorem of Danskin.** J. G. Wendel. 6-2-52. Unclassified.

A demonstration that the Brown-Robinson-Danskin iterative process for finding the value of a continuous game also "yields" solutions of the game. 3 pp.

- **RM-859 (ATI 210421). Some functional equations related to dynamic programming problems involving noncommutative operations.** O. A. Gross. 6-6-52. Unclassified.

A study of a type of functional equation relating to dynamic programming. A computation method for obtaining approximate and, in some cases, actual solutions is described. The associated decision procedures involve a fixed finite number of fixed choices at each stage. 18 pp. Illus.

- **RM-863 (AD 85346). The generalized outcome of a class of machine-gun duels.** G. E. Gompf. 6-13-52. Unclassified.

An attempt to determine the outcome of a duel between a machine-gun-defended bomber and a machine-gun-armed fighter after the fighter has succeeded in locating the bomber and has initiated a firing pass. One criterion—the maximum bomber kill obtainable by the fighter when the fighter consistently employs the same preferred opening-fire range against the bomber's best choice of a defensive—is selected for resolving the conflict of objectives. 81 pp. Illus.

- **RM-880 (ATI 210422). On the everywhere denseness of a certain semigroup of transformations.** H. N. Shapiro. 6-27-52. Unclassified.

A proof that the semigroup of transformations, generated by $L(x) = \alpha + (1 - \alpha)x$, $T(x) = \alpha x$, $0 \leq \alpha \leq 1$, $0 \leq \sigma \leq 1$, maps any given point of the unit interval everywhere dense in this interval, provided that $\sigma \geq \alpha$. 5 pp.

- **RM-881 (ATI 210423). Notes on the n -person game—IV: a theorem on C -stable sets.** L. S. Shapley. 7-11-52. Unclassified.

Solutions for the following set-equation, relevant to n -person game theory: $X = C - (X + R)$, where C and R are, respectively, a convex set and a cone in an n -dimensional vector space, satisfying certain conditions. 6 pp. Illus. See also RM-656, RM-670, RM-817, and RM-1005.

- **RM-884 (ATI 210424). More on games of survival.** M. P. Peisakoff. 6-20-52. Unclassified.

A demonstration that the game of survival, which is a repetition of a normalized finite zero-sum two-person game with each entry a nonzero integer, is inessential and has some easily described optimal strategies. 20 pp.

- **RM-885 (ATI 210425). U.S. flying weather.** R. R. Rapp. 7-1-52. Unclassified.

An attempt to determine the aerial distribution of adverse flying weather conditions by a simplification of meteorological observations. 13 pp. Illus.

- **RM-889 (ATI 210426). Optimal sets for games over the square.** I. L. Glicksberg and O. A. Gross. 7-25-52. Unclassified.

A proof that every nonvoid "weak" closed convex set of distributions on the unit interval is the set of all optimal strategies for one player in some game with continuous payoff over the square. 6 pp.

- **RM-890 (ATI 210427). The Systems Research Laboratory and its program.** R. L. Chapman, W. C. Biel, J. L. Kennedy, and A. Newell. 1-7-52. Unclassified.

A description of (1) a research program involving man-machine systems, (2) the laboratory in which the program is being pursued, and (3) a generalized model for organizational research. 25 pp. Illus. See also RM-887 and RM-922.

- **RM-894 (ATI 210428).** A characterization of the normal distribution. J. G. Wendel. 7-14-52. Unclassified.

A description of the normal distribution in terms of orthogonal transformations. 5 pp.

- **RM-895 (out of print).** On some variational problems occurring in dynamic programming theory—I. R. E. Bellman. 7-14-52. Unclassified.

A study to determine a rate of input for maximizing an over-all output. Mathematically this leads to the problem of determining functions, subject to certain naturally imposed conditions, so as to maximize certain functions of the solutions of a system of differential equations. 9 pp. Superseded by P-380.

- **RM-897 (ATI 210429).** Reduction of certain games over function space. W. H. Fleming and O. A. Gross. 7-11-52. Unclassified.

A study of a class of two-person zero-sum games over a space of measurable functions. Mixed-strategy solutions involving uniform translates of pure strategy are determined by reducing these games to games over the square. 7 pp.

- **RM-898 (ATI 210430).** An example of an infinite, nonconstant-sum game. L. S. Shapley. 7-18-52. Unclassified.

A simple example illustrating some of the questions which arise when an infinite general-sum game is solved for equilibrium points. 8 pp.

- **RM-900 (ATI 210446).** Quantitative theory of human behavior: the single individual. E. W. Barankin. 2-8-52. Unclassified.

A discussion of a new concept of probability (constructed from a theory of behavior) which determines the comparative behavioristic significance of convergence in probability and almost sure convergence. 89 pp.

- **RM-901 (ATI 210447).** Solution sets for games on the square. I. L. Glicksberg and O. A. Gross. 8-8-52. Unclassified.

A study of some necessary and sufficient conditions which show that a pair of non-void "weak" closed convex sets of strategies form the solution set of a game with continuous payoff on the square. 12 pp.

- **RM-905 (ATI 169032).** Axial and normal force coefficients for pointed bodies of revolution at super- and hypersonic speeds—part II: boattails. J. H. Huth and H. M. Dye. 8-5-52. Unclassified.

A study which serves as an aid to the aerodynamicist in optimizing missile design. Drag and lift increments are presented for a selected group of ogival and conical boattails (preceded by semi-infinite cylinders) in a Mach number range extending from 1.5 to infinity. In addition, comparisons are drawn between the ogival and corresponding inscribed conical boattails. 52 pp. Illus. See Part I, RM-844.

- **RM-909 (ATI 210448).** Some results in nonlinear programming. R. M. Thrall. 8-6-52. Unclassified.

A solution to a minimization problem which is used to treat a class of maximization problems. Possible applications of the results are discussed. 17 pp. See RM-935.

- **RM-913 (ATI 210449).** Aerial bombing tactics: general considerations (a World War II study). M. M. Flood. 9-2-52. Unclassified.

A discussion of the general tactical problem of aerial bombing and of the difficulties of assigning a gain to a completed operation. This study attempts to determine optimum tactics for use by very heavy bombers in operations against Japan. 39 pp. Illus.

- **RM-914 (ATI 210450).** Algorithm for computing optimum distribution of local defense. G. B. Dantzig. 8-12-52. Unclassified.

A computational algorithm on how to assign M defense units to T locations. It is assumed that the opponent will discover the assignment and will assign his N resources so as to maximize the sum of destruction over the T locations. 5 pp. See also RM-715.

- **RM-916 (ATI 210471). Reasonable outcomes for n -person games.** J. W. Milnor. 8-28-52. Unclassified.

A description of upper and lower bounds for the payoff which each coalition should get in any "reasonable" play of an n -person game. 16 pp. Illus.

- **RM-917 (out of print). National income of the USSR in 1928.** Oleg Hoeffding. 8-21-52. Unclassified.

Estimates of Soviet national income and product in 1928, expressed in current rubles. An attempt is made to determine (1) the incomes and outlays of households, (2) the consolidated net income and outlay account of government, social and economic organizations, (3) the gross national product account, and (4) the gross national product by use. 101 pp. Illus. Incorporated in R-255, *Soviet National Income and Product in 1928*, published by the Columbia University Press, New York, 1954. \$3.75.

- **RM-920. Prices of basic chemical products in the Soviet Union, 1928–1950.** A. Bergson and R. Bernaut. 8-28-52. Unclassified.

A study of the changes in Soviet wholesale chemical prices during the period 1928–1950. This study helps to determine a basis for calculating various deflators for national income data expressed in current rubles. 43 pp. Tables.

- **RM-921 (ATI 210472). A mathematical treatment of learning models.** Samuel Karlin. 9-2-52. Unclassified.

A mathematical analysis of transition operators arising in some learning models. A general linear learning model in one dimension is considered. 27 pp.

- RM-922. Observations and comments on the organization studies of the Systems Research Laboratory.** H. A. Simon. 8-29-52. Unclassified.

A summary of discussions with the Systems Research Laboratory staff concerning the concepts from organization theory which might be useful in analyzing data on the Ground Controlled Intercept Station experiment. 35 pp. See also RM-890.

- **RM-923. Leadership in Soviet agriculture and the Communist Party.** H. S. Dinerstein. 9-2-52. Unclassified.

An assessment of the functioning of leadership in Soviet agriculture and the Communist Party (up to December, 1949). In addition, background material is presented on the Soviet theory of leadership and the traditional attitudes and habits of the Russian peasant. 254 pp. Published as *Two Studies in Soviet Controls: Communism and the Russian Peasant*; *Moscow in Crisis*, The Free Press, Glencoe, Illinois, 1955. \$4.50.

- **RM-924 (ATI 210756). A tentative input-output table for the USSR, 1941 plan.** N. M. Kaplan, J. H. Blackman, H. Heymann, Jr., A. D. Redding, and N. W. Rodin. 9-2-52. Unclassified.

A preliminary input-output table for the USSR, which is consistent with the 1941 plan structure of the Soviet economy. Detailed sources and methods are presented in a series of appendices to the table. 153 pp. Illus. See also RM-1202.

- **RM-926 (ATI 210758). German youth and its attitude toward a German defense contribution.** Europa Archiv, Frankfurt A.M. 9-2-52. Unclassified.

A discussion of German youth and the attitude of youth organizations toward a defense contribution. This memorandum is one of a series of German studies, prepared by the Europa Archiv in conjunction with RAND. 46 pp. See also RM-927–930, RM-967, RM-968, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-927 (ATI 210759). The attitude of the Christian churches toward a German defense contribution.** Europa Archiv, Frankfurt A.M. 9-2-52. Unclassified.

An attempt to indicate the position for or against German participation in European defense by the Protestant and Catholic churches in Germany. 31 pp. See also RM-926, RM-928–930, RM-967, RM-968, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-928 (ATI 210760). German veterans' organizations and the defense contribution.** Europa Archiv, Frankfurt A.M. 9-2-52. Unclassified.

A summary description of German veterans' organizations and of their attitude toward current German defense policies. In addition, the conditions which would have to be met before their cooperation in rearming Germany could be secured are discussed. 47 pp. See also RM-926, RM-927, RM-929, RM-930, RM-967, RM-968, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-929 (ATI 210761). German labor unions and the question of German participation in European defense.** Europa Archiv, Frankfurt A.M. 9-2-52. Unclassified.

An historical review of trade unions in the Federal Republic and a development of a union position on Germany's defense contribution. 46 pp. See also RM-926-928, RM-930, RM-967, RM-968, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-930 (ATI 210762). The ideological groups in Germany and their attitude toward the defense contribution.** Europa Archiv, Frankfurt A.M. 9-2-52. Unclassified.

An attempt to determine the influence of "ideological groups" on German public opinion. These groups are described, together with an appraisal of their position regarding Germany's defense contribution. 31 pp. See also RM-926-929, RM-967, RM-968, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-933 (ATI 210473). Decision processes and functional equations.** S. Karlin and H. N. Shapiro. 9-3-52. Unclassified.

Data on the general question of the existence and uniqueness of solutions of problems in dynamic programming. 10 pp.

- **RM-935 (ATI 210474). Some results in nonlinear programming—part II.** R. M. Thrall. 9-5-52. Unclassified.

An extension of RM-909, *Some Results in Nonlinear Programming*. The solution of a minimization problem is determined in the vector case, and its properties are applied to a maximization problem. 15 pp.

- **RM-936 (ATI 210475). An experiment in mental generation of random numbers.** J. W. Milnor. 9-12-52. Unclassified.

An experimental attempt to study sequential behavior in the game of matching pennies as compared with behavior when a subject is asked to produce a random sequence. 13 pp. Illus.

- **RM-948 (ATI 210476). Some experimental n -person games.** G. Kalisch, J. W. Milnor, J. F. Nash, and E. D. Nering. 8-25-52. Unclassified.

An analysis of n -person coalition games. The pattern of behavior of the players is described, together with the relationship between the observed outcome of the games and various theoretical concepts. 44 pp. Illus.

- **RM-949 (ATI 210477). Some simple nonlinear models.** S. Karlin and H. N. Shapiro. 9-19-52. Unclassified.

A discussion of some nonlinear models of dynamic programming which are susceptible to complete analysis. 7 pp.

- **RM-950 (out of print). List of unclassified Mathematics Division publications, including related reports from other divisions.** Mathematics Division. Revised periodically. Unclassified.

RM-951 (ATI 210765). The problem of defining and measuring railroad capacity. H. Markowitz and R. N. Snow. 9-23-52. Unclassified.

An evaluation of railroad capacities in an attempt to determine what traffic can be handled in certain situations. In particular, the Trans-Siberian railroad is studied. 16 pp. Illus.

- **RM-953 (ATI 210478). Some group interaction models.** R. F. Bales, M. M. Flood, and A. S. Householder. 10-10-52. Unclassified.

A collection of memoranda describing the essential features of the human interaction process. This study is intended to develop adequate mathematical models of the human learning, decision, and interaction processes to provide a theoretical structure for the scientific study of organizational behavior. 66 pp. Illus.

- **RM-954 (ATI 210479). On predicting a combination of outputs and final demands by input-output.** G. H. Fisher and H. Markowitz. 10-3-52. Unclassified.

A presentation of a matrix which predicts (1) final demands from estimates of outputs and (2) outputs from estimates of final demands. 4 pp.

- **RM-958-1 (AD 109331). A field trial of an Air Force electronic equipment reliability study program.** F. A. Hadden and L. W. Sepmeyer. 6-17-54. Unclassified.

A description of a method for obtaining reliable data on equipment failures from Air Force field organizations. 40 pp. Tables. See also RM-1257 and P-573.

- **RM-967 (ATI 210767). Bundestag debates on Allied-German relations: Allied-German relations as reflected in selected debates of the Bundestag, January to April, 1952.** E. W. Schnitzer. 10-15-52. Unclassified.

A discussion of the negative (rather than the positive) aspects of Allied-German relations as reflected in selected debates of the Bundestag from January to April, 1952. 26 pp. See also RM-926-930, RM-968, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-968 (ATI 210768). Early discussions regarding a defense contribution in Germany (1948-1950).** Eric Willenz. 10-15-52. Unclassified.

A study of German reactions from 1948 to 1950 to the demands of the Allies for a Western German defense contribution. 23 pp. See also RM-926-930, RM-967, RM-981, RM-1056, RM-1119, and RM-1210.

- **RM-969 (ATI 210480). On a class of matrices with known characteristic roots and vectors.** R. E. Bellman. 10-31-52. Unclassified.

A presentation of a class of matrices of arbitrary order whose characteristic roots and vectors may be readily obtained. This study helps to determine the relative efficiency of various techniques for estimating characteristic roots and vectors of such arbitrary matrices. 5 pp.

- **RM-971 (ATI 210481). Duality in dynamic programming.** Samuel Karlin. 10-1-52. Unclassified.

A development of duality principles relating expected damage and cost, and the probability of achieving an objective and the time required in performing this objective. 9 pp.

- **RM-972 (out of print). On some variational problems occurring in the theory of dynamic programming—II.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 10-24-52. Unclassified.

Superseded by P-380.

- **RM-973 (out of print). On some variational problems occurring in the theory of dynamic programming—III.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 10-30-52. Unclassified.

Superseded by P-380.

- **RM-974 (out of print). International communication and political warfare: an annotated bibliography.** C. M. Smith, B. Winograd, and A. R. Jwaideh. 10-23-52. Unclassified.

A bibliography covering material published between 1943 and 1951 and including some works published as late as mid-1952. The publication may be viewed as a continuation of the bibliography presented in *Propaganda, Communication, and Public Opinion* by B. L. Smith, H. D. Lasswell, and R. D. Casey (Princeton University Press, Princeton, New Jersey, 1946). 508 pp.

RM-977 (AD 90418). Ritual of liquidation: the case of the Moscow trials. N. C. Leites and E. Bernaut. February 1954. Unclassified.

An analysis of the background and proceedings of the Moscow trials, which occurred in August, 1936; January, 1937; and March, 1938. This study is intended to contribute to the understanding of the present and future behavior of the ruling group in the Soviet Union. 515 pp. Published as *Ritual of Liquidation: Bolsheviks on Trial* by The Free Press, Glencoe, Illinois, 1954. \$6.50.

- **RM-978 (out of print). On some variational problems occurring in the theory of dynamic programming—IV.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 3-11-52. Unclassified.

Superseded by P-380.

- **RM-980 (out of print). On some variational problems occurring in the theory of dynamic programming—V.** R. E. Bellman and I. L. Glicksberg. 11-10-52. Unclassified.

Superseded by P-380.

- **RM-981 (ATI 210770). Public discussion in Western Germany of the defense of Europe, March to June, 1952.** E. W. Schnitzer. 10-31-52. Unclassified.

A supplement to a study concerned with West German attitudes relevant to western defense as shown by opinion polls. The present research memorandum provides a qualitative approach to this problem and related matters. 95 pp. See also RM-926-930, RM-967, RM-968, RM-1056, RM-1119, and RM-1210.

- **RM-989-1 (AD 111173). Some factors affecting the performance of a tracking radar.** Peter Swerling. 11-12-52. Rev. 9-27-54. Unclassified.

A study of the performance of a radar designed to detect, lock onto, and track a moving target. The results apply to split-gate range tracking or monopulse azimuth tracking. 67 pp. Illus.

RM-992 (ATI 210533). Inviscid aerodynamics of missiles with noncircular cross sections. J. H. Huth. 11-21-52. Unclassified.

A discussion of several methods which treat supersonic inviscid flow past ogive and cone cylinders with noncircular cross sections. In particular, the applications and limitations of relaxation and perturbation schemes are considered. 21 pp. Illus.

- **RM-994 (out of print). On some variational problems occurring in the theory of dynamic programming—VI.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 11-21-52. Unclassified.

Superseded by P-380.

RM-1002 (AD 85471). The cost of unreliability of Air Force airborne electronic equipment as represented by the cost of maintenance. R. L. Kirkwood and L. W. Sepmeyer. 12-3-52. Unclassified.

A study of the unreliability costs of Air Force airborne electronic equipment (as represented by the cost of maintenance) to determine the amount to be economically invested in obtaining reliability. 32 pp. Illus.

- **RM-1003 (ATI 210451). The Stalinist heritage in Soviet foreign policy.** N. C. Leites. 5-18-53. Unclassified.

An attempt to examine (1) Soviet foreign policy on the eve of the death of Stalin, (2) the bases of current policies, and (3) the background essential to interpret any future changes. 30 pp.

- **RM-1004 (ATI 210452). The statutes of the Communist Party: democratic façade and totalitarian reality.** N. C. Leites and E. Bernaut. 5-18-53. Unclassified.

A study of several developments concerning the role and nature of the Communist Party, as reflected in the new statutes adopted by the Nineteenth Bolshevik Congress. 22 pp.

- **RM-1005 (ATI 210453). *n*-Person games—V: stable-set solutions including an arbitrary closed component.** L. S. Shapley. 12-19-52. Unclassified.

A proof of a stable-set solution to a simple *n*-person game, which includes an arbitrary closed subset of a certain $(n - 3)$ -dimensional convex region in the simplex of imputations, at a finite distance from the rest of the solution. 10 pp. Illus. Also published as P-888. See also RM-656, RM-670, RM-817, and RM-881.

- **RM-1008 (ATI 210454). The "double threshold" method of detection.** Peter Swerling. 12-17-52. Unclassified.

A study which (1) determines the optimum value of the "double threshold" method of radar detection for several cases, and (2) considers signal to noise requirements in a comparison of a method of theoretically deriving the optimum second threshold for numerous hits with that of ideal integration of hits. 16 pp. See also RM-753, RM-754, RM-1217, and RM-1719.

- **RM-1009 (ATI 210777). Turboprop engine characteristics.** Propulsion Group, Aircraft Division. 12-11-52. Unclassified.

A presentation of the size, weight, and performance relations for a family of turboprop engines to provide powerplant information for strategic bombing systems studies. The synthesis methods required to produce the desired over-all performance characteristics are also described. 80 pp. Illus.

- **RM-1013 (ATI 210779). The heritage of Douhet.** Bernard Brodie. 12-31-52. Unclassified.

A general discussion of General Douhet's military philosophy and of his contributions to the theory of strategic aircraft use. 40 pp. Incorporated in R-335. Also incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, N.J., 1959. \$6.50.

- **RM-1019 (out of print). Comments on J. von Neumann's *The problem of optimal assignment in a two-person game*.** G. B. Dantzig. 7-21-52. Unclassified.

Superseded by P-435 of the same title.

- **RM-1027 (out of print). On the interaction of scalar and electrostatic fields.** R. L. Pease and J. S. Pease. 1-12-53. Unclassified.

A solution to nonlinear equations of coupled scalar and Maxwell fields in the static, spherically symmetric case. (A scalar source term has been added to these equations.) Expressions are obtained for the size and infinite energy of a single system, and for the interaction potential between two such systems. In addition, possible nuclear applications of the theory are considered. 29 pp.

- **RM-1029 (ATI 210455). Transmission of pulses over voice-quality telephone lines.** S. Bertram and J. D. Mallett. 1-19-53. Unclassified.

An examination of the pulse-type-signal handling capability of voice-quality telephone lines. 15 pp. Illus.

- **RM-1030. Prices of nonferrous metals in the Soviet Union, 1928 to 1950.** E. L. Turgeon and A. Bergson. 1-21-53. Unclassified.

A study to determine an index number of nonferrous metal prices in the Soviet Union from 1928 to 1950. Only nonferrous metals which are important from the standpoint of industrial use are considered. 96 pp. Tables.

- **RM-1037 (ATI 210781). Prices of road building and construction machines, USSR, 1928-1949.** R. H. Moorsteen. 2-11-53. Unclassified.

A summary of data on wholesale price movements of Soviet construction and road building machines from 1928-1949. This is part of a larger study concerned with wholesale price movements of all civilian machinery in the USSR for the same period. 24 pp. Illus.

- **RM-1038 (ATI 210456). The normal force and pressure distribution on a flat plate at normal incidence, in the presence of a moving vortex pair.** Irving Michelson. 1-1-53. Unclassified.

A study of the two-dimensional perfect fluid flow past an elementary shape of interest in order to apply the Munk-Jones slender body theory to the calculation of aerodynamic lifting force on bodies of noncircular cross section. 25 pp. Illus.

- **RM-1039 (AD 107262). Performance analysis methods for the twin-spool, high-pressure ratio, turbojet engine.** L. R. Woodworth. 10-15-52. Unclassified.

A presentation of the more accurate and refined performance analysis methods used for delineating between the aerothermodynamic design points of the twin-spool turbojet engine. 12 pp. Illus.

- **RM-1042 (ATI 210782). A dollar index of Soviet coal output, 1927/28-1937.** A. E. Nimitz (under the supervision of Alexander Gerschenkron). 2-18-53. Unclassified.

The third in a series of studies of heavy industry output in the USSR. The present memorandum attempts to measure the increase in Soviet coal output from 1927/28 to 1937 expressed in terms of U.S. dollars of 1939 purchasing power. 97 pp. Tables. See also R-197 (out of print), RM-804, and RM-1055.

- **RM-1044 (ATI 210457). The duplex system for IBM's Model II CPC: a fast four-address, double-operation, floating decimal setup.** William Orchard-Hays. 2-23-53. Unclassified.

A description of a floating decimal computing system for the Model II CPC (Card Programmed Calculator) with complete diagrams for wiring up a set of IBM plugboards. 42 pp. Illus.

- △ ● **RM-1045 (out of print). A stockpiling problem: mathematical treatment.** J. M. Danskin, Jr. 2-23-53. Unclassified.

A presentation of necessary conditions on the solution, if there is one, for the general case of a stockpiling problem. A complete solution is obtained for a special case. 18 pp. Also published as P-634.

- **RM-1047 (AD 97067). An investigation of atmospheric properties at great altitudes.** H. K. Kallmann. 2-27-53. Unclassified.

A quantitative analysis of the density, pressure, and kinetic temperature of the atmosphere at distances between 125 and 375 miles above the earth. Various atmospheric models are investigated, since direct observations of these quantities are not available at such altitudes. 55 pp. Illus.

- **RM-1055 (ATI 210784). A dollar index of Soviet iron and steel output, 1927/28-1937.** A. Gerschenkron and A. E. Nimitz. 3-13-53. Unclassified.

A recomputation of Soviet iron and steel industry output from 1927/28-1937, expressed in terms of U.S. dollars of 1939 purchasing power. This study is a continuation of R-197 (out of print), RM-804, and RM-1042. 266 pp. Tables.

- **RM-1056 (ATI 210458). Some developments in German aviation.** E. W. Schnitzer. 3-16-53. Unclassified.

A study, derived from current German aviation magazines, of the development of German civil aviation since 1945, when this activity was outlawed. 41 pp. See also RM-926-930, RM-967, RM-968, RM-981, RM-1119, and RM-1210.

- **RM-1058 (AD 111172). Chain reliability: a simple failure model for complex mechanisms.** W. J. Howard. 3-27-53. Unclassified.

A discussion of a simple example of a chain supporting a weight to determine how the reliability of a complex mechanism depends on the reliability of its components. The chain, consisting of several links, represents a complex mechanism composed of similar components, and the weight is analogous to a type of environmental stress which the mechanism must withstand without failure. 35 pp. Illus. See supplement RM-1724.

- **RM-1068 (ATI 210577). Optimum tactics in an air superiority campaign.** A. S. Mengel. 4-9-53. Unclassified.

An application of the calculus of variations to an investigation of the optimum tactics in an air superiority campaign described by a simple set of Lanchester-type differential equations. This study determines: (1) a straightforward definition of air superiority, (2) the numerical advantage required to obtain it, and (3) a simple rule for allocating sorties between counter-air and counter-surface missions to maximize the relative support given the ground troops. 26 pp. Illus.

- **RM-1069 (ATI 210459).** On an application of the theory of dynamic programming to bottleneck problems in production and allocation. R. E. Bellman. 4-14-53. Unclassified.

The title describes the aim and content of this publication. 8 pp.

- **RM-1071.** Prices of paints in the Soviet Union, 1928–1950. R. Bernaut and A. Bergson. 4-16-53. Unclassified.

A study of the changes in Soviet wholesale paint prices from 1928 to 1950. This memorandum is part of a larger project, which attempts to determine a basis for calculating various deflators for national income data expressed in current rubles. 83 pp. Tables.

- **RM-1072 (out of print).** The rate of advance of the front line in some World War II campaigns. R. P. Mulholland and R. D. Specht. 4-16-53. Unclassified.

A study which analyzes the velocity of the front line as related to the strengths of the opposing forces in the European and Mediterranean theaters of World War II. 27 pp. Illus.

- **RM-1085 (AD 101886).** Process analysis of the metal-working industries. Harry Markowitz. 5-12-53. Unclassified.

An analysis of such major areas as metal working, fuel and power, and chemicals to formalize a model of each sector and the interrelations of sectors, and to determine from available data and engineering estimates a production function for the economy as a whole. 26 pp. Tables.

- **RM-1086.** The new Soviet leadership. R. L. Garthoff. 5-1-53. Unclassified.

An evaluation of current developments in Soviet leadership up to May, 1953. The proceedings of the Nineteenth Party Congress in October, 1952, are examined, together with the changes in the organization and composition of the policymaking and instrumental levels of Soviet leadership. 46 pp. Tables.

- **RM-1087 (ATI 210460).** A problem in programming steel production and its solution by differential game theory. R. P. Isaacs. 5-15-53. Unclassified.

An application of differential game theory to determine a straightforward solution to an allocation problem. 23 pp. Illus.

- **RM-1091 (ATI 210461).** A review of the steel industry of the United States. S. M. Marshall. 4-21-53. Unclassified.

An analysis showing detailed construction requirements per ton of annual ingot capacity in integrated steel plants. For each component of a mill, cost estimates are determined in terms of materials, man-hours, and 1953 dollars. The study assumes that existing steel-mill equipment is reproduced and that no new capacity is optimally added under current conditions. 80 pp. Tables.

- **RM-1094 (ATI 210536).** Distributions of surviving bombers in certain air battle models. W. J. Dixon. 5-1-53. Unclassified.

A comparison of alternative approximations for the distribution and expected value of the number of surviving bombers in a homogeneous cell. This cell is subjected to successive waves of attacks identical with respect to both the number of attackers and the effectiveness of each attacker. 35 pp. Tables. See also RM-1396.

- △ ● **RM-1096 (out of print).** On a new iterative algorithm for finding the solutions of games and linear programming problems. R. E. Bellman. 6-1-53. Unclassified.

A new iterative algorithm which is furnished by a discrete analogue to a variant of the differential equation approach. 15 pp. Also published as P-473.

- **RM-1097 (ATI 210788).** An approximation for computing the survival of a two-dimensional diffuse target. F. P. Ballantyne. 4-2-53. Unclassified.

An approximation for computing the survival probability of a singly vulnerable elliptical diffuse target model when (1) the distribution of projectiles, in the plane of the target, forms an elliptic

dispersion pattern about the aim point, (2) the location of the aim point is random from firing to firing and has elliptical normal distribution about the target center, and (3) the principal axes of the elliptical target, the elliptical dispersion pattern, and the elliptical distribution of aim points all have a common orientation. 9 pp. Illus.

- **RM-1102 (ATI 210482). A production-line assignment problem.** D. R. Fulkerson, I. L. Glicksberg, and O. A. Gross. 5-27-53. Unclassified.

A description of a production-line problem of the bottleneck type. Its solution is given by relating it to the optimal assignment problem solved by J. von Neumann, G. B. Dantzig, and others. 3 pp.

- **RM-1112 (ATI 210790). Prices of metalworking equipment in the Soviet Union, 1928–1951.** E. L. Turgeon (under the supervision of Abram Bergson). 6-30-53. Unclassified.

One of RAND's studies which attempt to determine the war potential and vulnerabilities of the Soviet economy. The present memorandum calculates the index numbers of metalworking equipment prices in the USSR from 1928 to 1951. 76 pp. Tables.

- **RM-1116 (ATI 210792). Productivity in Soviet iron mining, 1890–1960.** N. W. Rodin. 7-7-53. Unclassified.

Another RAND study which attempts to determine the capability and growth of Soviet economic war potential. The present research memorandum analyzes the labor productivity trends in Soviet iron mining from 1890 to 1940. In addition, the approximate productivity level expected in 1960 is estimated. 50 pp. Tables.

- **RM-1119 (ATI 210793). Soviet policy on the reunification of Germany, 1945–1952.** E. W. Schnitzer. 7-15-53. Unclassified.

A review of Soviet statements of policy on the reunification of Germany from 1945 to 1952. This study, which shows how the division of Germany has deepened and negotiations have deadlocked, may be useful as background material for understanding the June, 1953, East German rebellion. 81 pp. See also RM-926–930, RM-967, RM-968, RM-981, RM-1056, and RM-1210.

- **RM-1121 (ATI 210483). Prices of tractors, trucks, and automobiles, USSR, 1928–1949.** R. H. Moorsteen. 7-23-53. Unclassified.

Data on wholesale price movements of tractors, trucks, and automobiles in the USSR from 1928 to 1949. This is part of a broader investigation to determine the war potential and vulnerabilities of the Soviet economy. 143 pp. Tables.

- △ **RM-1125 (out of print). On continuous versions of dynamic-programming problems—III (two interdependent industries with no capacity constraints).** R. E. Bellman and S. Lehman. 7-31-53. Unclassified.

A presentation of a typical problem involving the optimal allocation of the resources of two interdependent industries. 28 pp. See also P-492 (out of print).

- **RM-1126 (out of print). On continuous versions of dynamic programming problems—IV (duality theorems for bottleneck problems).** R. E. Bellman and S. Lehman. 7-31-53. Unclassified.

A demonstration that the simultaneous consideration of the original problem plus its dual yields a considerable simplification to the bottleneck problem. 6 pp.

- **RM-1127 (ATI 210794). Fatigue analysis of aircraft structures.** F. R. Shanley. 7-31-53. Unclassified.

An outline of a simple stress-analysis procedure which accounts satisfactorily for the entire life-time loading of the airplane and forms a basis for future airworthiness requirements. The various factors which govern the behavior of the structure under repeated loads are investigated, using the theory of fatigue developed in P-350, *A Theory of Fatigue Based on Unbonding during Reversed Slip*. In addition, this study makes recommendations for (1) airworthiness requirements for fatigue and (2) research needed for further improvement of fatigue requirements and stress analysis methods. 72 pp. Illus. See also RM-1198 and RM-1439.

- **RM-1129 (ATI 210484). Boundary-layer drag for nonsmooth surfaces.** W. W. Gollos. 6-24-53. Unclassified.

A study of the turbulent boundary-layer drag for production-type or nonideal aircraft surfaces. This research memorandum discusses (1) both the internal mechanism of the incompressible turbulent-boundary layer and basic empirical results, as affected by surface roughness, and (2) the effects of the compressibility in the turbulent boundary layer up to the point where the roughness elements themselves become locally affected and are no longer immersed in an incompressible field. 19 pp. Illus.

- **RM-1131 (AD 80637). A survey of the current status of the electronic reliability problem.** R. R. Carhart. 8-14-53. Unclassified.

An evaluation of reliability as a systems problem. The study examines (1) the general background of the problem, (2) tube, component, and system reliability, (3) personnel and organizational factors, (4) the theory of reliability, and (5) the application of the theory to military electronics. The concept of critical complexity is introduced, and reliability control is suggested as an effective means of achieving and maintaining reliability in the development, production, and use of complex electronic systems. 136 pp. Illus.

- **RM-1136. Prices of cement in the Soviet Union, 1928-1950.** R. Bernaut and A. Bergson. 8-24-53. Unclassified.

Part of a larger RAND program to determine the war potential and vulnerabilities of the Soviet economy. The present research memorandum discusses changes in wholesale cement prices from 1928 to 1950. 58 pp. Tables.

- **RM-1140 (ATI 210796). Algebraic solution of linear-programming problems.** J. G. Kemeny. 8-28-53. Unclassified.

An illustration of certain algebraic solutions for linear-programming problems in order to show that in the case of reasonably simple problems these techniques are superior to the usual machine-methods. 43 pp. Illus.

- **RM-1142 (ATI 210485). Order matrices—I.** L. S. Shapley. 9-4-53. Unclassified.

A definition of the order matrix of a two-person matrix game. Its maximal undominated sub-matrix, or saddle, is described, and a method is given for locating elements of the saddle. 9 pp. See also RM-1145.

- **RM-1145 (ATI 210486). Order matrices—II.** L. S. Shapley. 9-15-53. Unclassified.

A proof that the center of an order matrix (defined as the smallest carrier for the solutions of all the associated numerical matrices) lies between the residual set and the saddle, provided that the order matrix contains no equal elements. 10 pp. See also RM-1142.

- **RM-1151. Response of drag-type structure to blast.** L. A. Gore and J. J. O'Sullivan. 10-16-53. Unclassified.

An attempt to show that the major damage to structures is caused by drag forces associated with the high speed winds of long duration following the shock wave. 13 pp. Illus. See also RM-1235 and RM-1236.

- **RM-1153-AEC. Ionization of radioactive particles in the free air.** S. M. Greenfield. 7-5-55. Unclassified.

A study of the possibility of particles becoming ionized as they undergo radioactive decay. The resulting charge of either sign, existing for a relatively small time period, is shown to be statistically negligible. 14 pp.

- **RM-1158 (AD 85480). Image brightness intensifiers.** Radio Corporation of America. 11-10-53. Unclassified.

A discussion of (1) the fundamental limits of image formation and brightness intensification, (2) various classes of image brightness intensifiers and the problems they present, (3) the experiments to date in the image intensifier field, and (4) a tentative evaluation of the usefulness of this class of device. 53 pp. Illus.

- **RM-1159 (ATI 210487). Behavior of metals at high rates of loading.** W. T. Thomson. 11-12-53. Unclassified.

A discussion, from a thermodynamic standpoint, of the inelastic behavior of metals at very high rates of deformation. 16 pp. Illus.

- **RM-1160 (AD 86833). An approximate theory of armor penetration.** W. T. Thomson. 11-12-53. Unclassified.

An attempt to determine an approximate theory of armor penetration where the thickness of the plate is small compared with the size of the hole. 10 pp. Illus.

- △● **RM-1163 (ATI 210488) (out of print). Communication and learning in task-oriented groups.** Massachusetts Institute of Technology. 12-1-53. Unclassified.

A study of the principal theoretical and experimental developments of the Group Networks Laboratory (at the Research Laboratory of Electronics, M.I.T.) from August, 1949, to April, 1952. In particular, the concepts of communication and learning in human groups, which have been task-oriented and whose function is to effect assigned changes in some part of their external environment, are examined. 255 pp. Illus.

- RM-1171 (ATI 210566). A tactical air game.** D. R. Fulkerson and S. M. Johnson. 12-14-53. Unclassified.

A formulation of a discrete, linear analogue of Mengel's model of a tactical air war as a game (described in RM-1068). The symmetric case in which the attrition rates are the same for both sides is solved for both finite and infinite campaigns. 20 pp. See revised version P-1063.

- **RM-1173 (ATI 210803). The new Soviet plans for agriculture and consumption.** Oleg Hoeffding. 12-23-53. Unclassified.

A preliminary appraisal of recent Soviet measures to expand production and sales of consumer goods and to increase output and marketings in selected branches of agriculture. This study deals particularly with the intended effects of these measures on USSR consumption levels and prospects of their realization, their likely impact upon Russian resource allocation, and their implications concerning Soviet foreign policy and internal political conditions. 60 pp. Tables.

- **RM-1178 (ATI 210489). The new Soviet agricultural decrees (September Plenum, 1953).** A. E. Nimitz. 1-13-54. Unclassified.

A discussion of various documents, published in *Pravda* from August 9 to October 1, 1953, in which the Soviet government analyzed the present defects of Soviet agriculture, condemned some past errors in agricultural policy, and announced a program to increase agricultural output. 92 pp. Tables.

- RM-1179 (AD 107437). Preliminary study of turbojets for Mach 2.75.** Propulsion Group, Aircraft Division. 1-5-54. Unclassified.

A brief study of the performance capabilities of a family of afterburning turbojets. Specific weight and fuel consumption curves are presented for three turbojet designs with a common capability of Mach 2.75 at the tropopause. In addition, performance estimates are given for all Mach numbers between 0.9 and 2.75 for both military dry and full afterburning operation. 29 pp. Illus.

- **RM-1181 (AD 109957). A theoretical treatment of spalling.** J. H. Huth and J. D. Cole. 1-27-54. Unclassified.

A theoretical examination of spall formation on the back side of armor which has been subjected to a frontal explosive attack. This study may serve as background material for problems concerned with target destruction. 19 pp. Illus.

- **RM-1186. Prices of bricks in the Soviet Union, 1928-1950.** Roman Bernaut (under the supervision of Abram Bergson). 2-2-54. Unclassified.

Part of a broader investigation to determine the war potential and vulnerabilities of the USSR economy. The present study deals with compiled data on wholesale price changes in Soviet bricks from 1928 to 1950. 46 pp. Tables.

- **RM-1190 (AD 109958). Some characteristics of manufacturers' parts numbers now included in Air Force catalogs.** Stephen Enke. 2-17-54. Unclassified.

A study analyzing a sample of parts numbers of manufacturers in an attempt to determine which designation should be used in various areas of the logistics system for Air Force identification of inventory items. 3 pp. Table.

- **RM-1194. Scientific uses for a satellite vehicle.** R. R. Carhart. 2-12-54. Unclassified.

A discussion of the utility of the satellite for scientific investigation. This study (1) emphasizes data obtained in the early unrecoverable, unmanned vehicle and relayed to earth by radio or television and (2) examines such major areas as astronomy, terrestrial observations, and cosmic rays. 35 pp.

- **RM-1198 (AD 86835). Proposal for reduction of factors of safety for military airplanes.** F. R. Shanley. 1-15-54. Unclassified.

A proposal that the structural weight of military aircraft be reduced by lowering the design safety factor—provided new methods of fatigue stress analysis are adopted. 12 pp. Illus. See also RM-1127 and P-350.

- **RM-1199-1 (AD 85487). Distribution of indirect costs: a method of allocating the cost of Air Force interdependent support activities to mission activities.** G. H. Fisher. 1-26-55. Rev. 2-4-55. Unclassified.

An analysis of an interactivity flow model to solve the cost accounting problem arising when the costs of interdependent support (indirect) activities are to be allocated or distributed to basic mission (direct or end-product) activities. 20 pp. Illus.

- **RM-1201 (AD 85421). A simplified physical interpretation of Whitcomb's "area rule" for the reduction of supersonic pressure drag.** Richard Schamberg. 2-17-54. Unclassified.

An attempt to illustrate several underlying theoretical principles of the area rules for reducing both the transonic drag rise and the supersonic pressure drag of aircraft configurations. The study assumes potential flow and linearized supersonic theory and describes an example involving a swept-back wing (at zero lift). 19 pp. Illus.

- **RM-1202 (AD 114131). Approaches to Soviet inter-industry relationships.** N. M. Kaplan and M. Hoffenberg. 3-2-54. Unclassified.

Part of a broader investigation to determine the war potential and vulnerabilities of the Soviet economy. The present study uses the U.S. 1947 matrix of input-output coefficients to generate USSR final demands (or gross outputs) from USSR gross outputs (or final demands). 30 pp. Tables. See also RM-924.

- **RM-1203-AEC. Polynomial approximations to neutron-deuteron differential angular cross sections.** Harold Zirin. 6-5-53. Unclassified.

An attempt to describe the experimental measurements of (n,d) angular cross sections for computational purposes. The differential cross sections are approximated by a series of Legendre polynomials with energy-dependent coefficients, and smooth curves are drawn for the coefficients at various energies of incidence. 17 pp. Illus.

- **RM-1205 (AD 86836). Approximate methods for determining the performance of gas turbine engines at off-design conditions.** W. B. Gist and L. R. Woodworth. 3-5-54. Unclassified.

An attempt to determine equilibrium operating conditions in the gas turbine at flight conditions and power settings other than the design point—by deriving analytical relations among the pressures, temperatures, and gas flow quantities throughout a gas turbine engine. These equations, intended to facilitate computing part-load and off-design-point internal performance, may be applied to turbojets, turbofans, or turboprops in which the assumed design conditions exist. 66 pp. Illus.

- **RM-1208-AEC (AD 86837). Hydrogen wave-functions.** Richard Latter. 3-10-54. Unclassified.

A graphical presentation of the results of detailed hydrogenic wave-function calculations. 57 pp. Illus.

- **RM-1210 (AD 114132). German geopolitics revived: a survey of geopolitical writing in Germany today.** E. W. Schnitzer. 3-19-54. Unclassified.

An attempt to evaluate the revival in Germany of the geopolitical thought of the 1920's and 1930's—as reflected in the writings of its current exponents and, particularly, in *Zeitschrift für Geopolitik*, the scientific organ of the geopolitical school. 97 pp. See condensed version P-501. See also RM-926-930, RM-967, RM-968, RM-981, RM-1056, and RM-1119.

- **RM-1217 (AD 80638). Probability of detection for fluctuating targets.** Peter Swerling. 3-17-54. Unclassified.

An analysis of the probability of detection of a target by a pulsed search radar, when the target has a fluctuating cross section. Formulas for detection probability and curves of detection probability versus range are considered for several models of target fluctuation. 38 pp. Illus. See also RM-753, RM-754, RM-1008, and RM-1719.

- **RM-1220 (AD 85423). Statistical theory of navigation employing independent inertial and velocity measurements.** P. Swerling and E. Reich. 3-25-54. Unclassified.

A theoretical study of optimum determination of position by a navigation device employing independent inertial and velocity measurements, which are subject to random errors. This problem is related to the theory of statistical estimation as well as to filtering theory. 56 pp. See also RM-1321

- △● **RM-1222 (AD 85424) (out of print). Considerations for research in a sleep-learning program.** C. W. Simon and W. H. Emmons. 9-13-54. Unclassified.

A summary of some experimental evidence concerning sleep-training problems. This investigation discusses (1) the extent of sleep-learning studies and their evaluation and (2) psycho-physiological considerations for sleep-learning. In addition, the RAND sleep-learning laboratory is described. 74 pp. Illus. Also published as P-565.

- **RM-1223 (AD 85425) (out of print). The metamorphosis of the Stalin myth.** R. C. Tucker. 4-16-54. Unclassified.

An attempt to interpret the new "Stalin myth" and the emerging "cult of the Party" in Russia. Certain aspects of the post-Stalin train of events are investigated, and various trends and issues in the internal political life of the USSR since Stalin's death are noted. 40 pp. Also published as P-507.

- **RM-1225 (AD 90496). Prices of prime movers, USSR, 1927/28-1949.** R. H. Moorsteen. 3-30-54. Unclassified.

Data on wholesale price movements of prime movers in the USSR from 1927/28 through 1949. This is part of a broader investigation to determine the war potential and vulnerabilities of the Soviet economy. 169 pp. Tables.

- **RM-1226 (AD 86913). Residual gamma radiation hazard after limited decontamination operations.** F. J. Krieger. 4-1-54. Unclassified.

Calculations showing the reduction of the radiation level attained over a specified area by the complete or partial removal of the radioactive contamination from that area. The geometrical configurations considered are a circular area of variable radius and an infinitely long strip of variable width. 18 pp. Illus.

- **RM-1227 (AD 116576). Equation of state on the Thomas-Fermi model—part I: non-zero temperature.** Richard Latter. 4-1-54. Unclassified.

One of three studies which (1) solve the Thomas-Fermi equation for all elements, temperatures, and pressures and (2) derive several analytic approximations sufficiently accurate under certain limiting conditions. The present research memorandum (Part I) deals with the general temperature-dependent case of the Thomas-Fermi atom. 119 pp. Illus. See also RM-1228 and RM-1229.

RM-1228 (AD 116577). Equation of state on the Thomas-Fermi model—part II: zero temperature without exchange. Richard Latter. 4-1-54. Unclassified.

An extension of RM-1227. The present study (Part II) considers the Thomas-Fermi model of the atom at zero temperature without exchange. 23 pp. Illus. See also RM-1229.

RM-1229 (AD 116578). Equation of state on the Thomas-Fermi model—part III: zero temperature with exchange. Richard Latter. 4-1-54. Unclassified.

A continuation of RM-1227 and RM-1228, which solved the Thomas-Fermi equation for the general temperature-dependent case and at zero temperature without exchange. This research memorandum (Part III) studies the Thomas-Fermi model at zero temperature with exchange. 21 pp. Illus.

• **RM-1237-AEC (AD 94552). Application of Monte Carlo.** Herman Kahn. 4-19-54. Rev. 4-27-56. Unclassified.

A discussion of some of the ideas and techniques of the Monte Carlo method (applying probability theory and statistics to applied mathematics) which have proven useful in the solution of various problems. The study considers techniques with random variables, evaluating integrals, integral or matrix equations, and ordinary differential equations. 256 pp. Illus.

RM-1238 (AD 85427). Detection range of an active radar seeker. J. D. Mallett and P. Swerling. 4-20-54. Unclassified.

An analysis of the effect of various factors on the detection range of an active radar seeker. An attempt is made to (1) determine the theoretical range of a seeker, (2) present graphs which show how these factors affect detection range and which aid in choosing optimum parameters, and (3) apply these results to several cases representative of actual or proposed seekers. 36 pp. Illus.

• **RM-1241 (AD 86914). On the limiting behavior of discrete dynamic-programming processes—I (the gold-mining problem).** R. E. Bellman. 4-19-54. Unclassified.

One of several studies in which the limiting behavior of certain classes of dynamic programming processes is examined, as various parameters defining the processes tend to zero. In particular, the gold-mining problem is considered. 9 pp. See also RM-1242 and RM-1243.

• **RM-1242 (AD 89227). On the limiting behavior of discrete dynamic-programming processes—II (a direct proof of convergence).** R. E. Bellman. 4-26-54. Unclassified.

A direct proof of a certain convergence which is given independently of the concept of a continuous process. 8 pp. See also RM-1241 and RM-1243.

• **RM-1243 (AD 109959). On the limiting behavior of discrete dynamic-programming processes—III (the generalized gold-mining problem).** R. E. Bellman. 5-3-54. Unclassified.

A generalization of the gold-mining problem, considered in RM-1241 of the same title. In the limit the generalized version is shown to reduce to the simpler version. 5 pp. See also RM-1242.

RM-1244 (AD 90497). Prices of industrial electric power in the Soviet Union, 1928 to 1950. E. L. Turgeon (under the supervision of Abram Bergson). 4-27-54. Unclassified.

Data on the index numbers of electric energy prices used by Soviet industry from 1928 to 1950. This is part of a broader investigation to provide a basis for calculating the dollar equivalent of current Russian industrial and military output. 62 pp. Tables.

• **RM-1248 (AD 85428). The agricultural labor force and population of the USSR: 1926-41.** Warren Eason. 5-4-54. Unclassified.

A description of the economic and social structure of Soviet agriculture during the first three five-year plans measured in terms of the size and age-sex composition of the population. This study is one in a series which measures trends in USSR economic development. 217 pp. Tables.

- RM-1250 (AD 90498). Statistics of Soviet agriculture. A. E. Nimitz. 5-7-54. Unclassified.

Data on the output and productive capital of Soviet agriculture from 1928 to 1953, excluding the war years. This is part of a larger inquiry to determine the war potential and vulnerabilities of the USSR economy. 96 pp. Tables.

- RM-1251 (AD 85429). The D.P.F.D.: a double precision (18 digits) floating decimal setup for IBM's Model II CPC. J. P. Wong, Jr. 5-13-54. Unclassified.

A description of a three address, double precision (18 digits) floating decimal computing system, called the D.P.F.D., for IBM's Model II Card Programmed Calculator. A complete set of diagrams for wiring a set of IBM plug panels for this system is considered. 44 pp. Illus.

- △● RM-1254 (AD 85430) (out of print). The nature and applications of process analysis. H. M. Markowitz. 5-24-54. Unclassified.

A study to determine what combinations of civilian and military outputs may be produced with specified national resources. The author discusses (1) the detail entering a process analysis model, (2) the questions answered by such a model, and (3) various considerations involved in the building, testing, and using of a process analysis model of the economy as a whole. 23 pp. Tables. Also published as P-547.

- RM-1257 (AD 85481). Electronic reliability and supply improvement based on failure reporting and presentation. L. W. Sepmeyer and F. A. Hadden. 5-25-54. Unclassified.

A summary of the results of RM-958-1, *A Field Trial on an Air Force Electronic Equipment Reliability Study Program*. The present study describes a method which reports field failure and replacements in an attempt to provide a tool for controlling equipment reliability. 60 pp. Illus. See also P-573.

- RM-1258 (AD 90499). Prices of railroad rolling stock, USSR—1927/28–1949. R. H. Moorsteen. 5-27-54. Unclassified.

Data on the trend of wholesale prices of railroad rolling stock in the USSR from 1927/8 to 1949. This is one of several studies expected to provide a basis for calculating changes over time in the structure of the Soviet economy. 66 pp. Tables.

- RM-1263 (AD 85482). The geographic distribution of metal-working equipment. H. M. Markowitz. 6-10-54. Unclassified.

Data on the distribution of metal-working machinery by industry, type, and geographical location. This analysis indicates that the quantity of the various machines outside metropolitan areas is sufficient for substantial military output. 12 pp. Tables.

- RM-1264 (AD 114134). Notes on linear programming—part I: the generalized simplex method for minimizing a linear form under linear inequality restraints. G. B. Dantzig, A. Orden, and P. Wolfe. 4-5-54. Unclassified.

The first of a series of papers on the determination of optimum solutions to systems of linear inequalities. The present paper develops a theory for avoiding assumptions regarding rank of underlying matrices which has import in applications where little or nothing is known about the rank of some linear inequality system requiring solution. 17 pp. Also published as P-392 (out of print). See also RM-1265 and RM-1266.

- RM-1265 (AD 114135). Notes on linear programming—part II: duality theorems. G. B. Dantzig and A. Orden. 10-30-53. Unclassified.

A demonstration that the simplex procedure itself yields as a natural by-product proofs of several important theorems concerned with duality in the field of linear inequalities. 4 pp. See also RM-1264 and RM-1266.

- RM-1266 (AD 114136). Notes on linear programming—part III: computational algorithm of the revised simplex method. G. B. Dantzig. 10-26-53. Unclassified.

An extension of RM-1264 and RM-1265. Parts I and II, respectively, of *Notes on Linear Programming*. The present study presents the computational procedure. 7 pp. Tables.

- **RM-1267-1 (AD 114137). Notes on linear programming—part IV: constructive proof of the minmax theorem.** G. B. Dantzig. 12-18-53. Rev. 9-8-54. Unclassified.

A short algebraic proof of the fundamental theorem of games that is elementary and constructive. A simple example illustrates the method. 17 pp. Also published as P-564.

- **RM-1268 (AD 114138). Notes on linear programming—part V: alternate algorithm for the revised simplex method using a product form for the inverse.** G. B. Dantzig and W. Orchard-Hays. 11-19-53. Unclassified.

A description of a finite iterative procedure, using a product form for the inverse. 13 pp. See also RM-1268A.

- **RM-1268A (AD 90500). Notes on linear programming—part V: a product-form tableau for revised simplex method—computing appendix for RM-1268** G. B. Dantzig, W. Orchard-Hays, and G. Waters. 5-19-54. Unclassified

A computing appendix for RM-1268, *Notes on Linear Programming—Part V: Alternate Algorithm for the Revised Simplex Method Using Product Form for the Inverse*. The method considered is applied to a linear programming problem (requiring the minimization of a given functional subject to linear restraints) in order to illustrate the tableau. 19 pp. Tables.

- **RM-1269 (out of print). Notes on linear programming—part VI: the RAND code for the simplex method.** William Orchard-Hays. 1-20-54. Unclassified.

A basic reference paper giving the first two of a series of codes (for the IBM 701 calculator) which performs the simplex method. This method, incorporating all modifications as used in the code, is reviewed. 34 pp. Illus. See also RM-1440.

- **RM-1270 (AD 114139). Notes on linear programming—part VII: the dual simplex algorithm.** G. B. Dantzig. 5-3-54. Rev. 7-3-54. Unclassified.

A procedure for solving the dual problem by means of variables associated with a basis that may have negative as well as positive values in the iterative process before an optimum is reached. 10 pp.

- **RM-1274 (AD 114140). Notes on linear programming—part XI: composite simplex—dual simplex algorithm—I.** G. B. Dantzig. 4-26-54. Unclassified.

A proposal for avoiding certain undesirable features of Phase I of the simplex method (i.e., by the introduction of vectors on the basis that they are likely to be in the optimal solution of Phase II). 16 pp. See RM-1275.

- **RM-1275 (AD 114141). Notes on linear programming—part XII: a composite simplex algorithm—II.** William Orchard-Hays. 5-7-54. Unclassified.

A proposal which combines the normal and dual algorithms, with some modifications, in order to determine an optimal solution in fewer iterations than by other methods. The present study separates the nonsingularity of a basis matrix and the feasibility and the optimality of the solution. 15 pp. See RM-1274.

- **RM-1281. Notes on linear programming—part XIII: optimal solution of a dynamic Leontief model with substitution.** G. B. Dantzig. 6-15-54. Unclassified.

An examination of a dynamic Leontief system of the discrete type. Alternative substitute type activities are allowed; a bill of goods is given over time; and the unknown quantities of activities satisfying the system are determined in order to minimize a specified linear objective function. 13 pp.

- **RM-1282 (AD 86919). A dollar index of Soviet electric-power output.** Alexander Gerschenkron. 6-24-54. Unclassified.

An attempt to measure Soviet power output in dollars from 1927/28 to 1937, so that power output may be combined with the output, measured in dollars, of other branches of Soviet heavy industry. This is one of several studies expected to provide a basis for calculating the dollar equivalent of current Soviet industrial and military output. 104 pp. Tables.

- **RM-1285-1 (AD 114142). Effects of environment in reducing dose rates produced by radioactive fallout from nuclear explosions.** J. E. Hill. 9-28-54. Unclassified.
A summary of the factors by which the infinite plane dose rate of fission product gammas would be reduced in various situations. 10 pp. Illus.

- **RM-1286 (AD 85483). The derivatives of the value of a game.** O. A. Gross. 3-10-54. Unclassified.

A proof that the right- and left-hand derivatives of the value of a finite, two-person, zero-sum game, with respect to an element of the payoff, exist and are expressible in terms of the optimal strategies. 4 pp.

- **RM-1290 (AD 109960). Notes on linear programming—part XIV: a computational procedure for a scheduling problem of Edie.** G. B. Dantzig. 7-1-54. Unclassified.

A presentation of two methods for assigning workers optimally to jobs in a dynamic situation. It is assumed that the number of men on the job varies to meet a specified (nonconstant) work load throughout the day and that the work pattern of each worker varies as to starting and leaving time, providing breaks for rests and meals. 13 pp. Illus.

- **RM-1294 (AD 90502). A comparison of Soviet and United States retail food prices for 1950.** E. S. Wainstein. 7-13-54. Unclassified.

Part of a larger study to determine the dollar equivalent of current Soviet industrial and military output. The present study compares USSR and U.S. retail food prices for 1950. 46 pp. Tables. See also RM-707-1.

- **RM-1296 (AD 85484). Consistency problems in the military supply system.** Oskar Morgenstern. 7-14-54. Unclassified.

An attempt to establish procedures that guarantee the functioning of a military supply system, composed essentially of several overseas bases. Each base is assumed to support different activities and to be supplied by a domestic supply center. 31 pp.

- RM-1297 (AD 85485). Analysis of the demand patterns for B-47 airframe parts at air base level.** B. B. Brown and M. A. Geisler. 7-27-54. Unclassified.

An analysis of the demand patterns for B-47 airframe spare items (sub-property class 01A-FE), requested daily at March Air Force Base from March to September, 1953. 18 pp. Tables.

- RM-1298 (AD 85486). Effects of impulsive deflections on ballistic missile trajectories.** I. S. Blumenthal. 7-28-54. Unclassified.

A mathematical analysis of the sensitivity of long-range ballistic missiles to deflection from an assigned target by an accelerating impulse applied during the free-flight phase. The quantitative relationship between the accelerating impulse and the target deflection is determined and is shown to depend on the original trajectory and the point in space where the impulse occurs. 27 pp. Illus.

- RM-1300 (AD 85488). Predictability of demand for B-47 airframe spare items.** M. A. Geisler and J. W. T. Youngs. 8-4-54. Unclassified.

A discussion of the effect that a low demand rate for a spare part has on the development of a rational policy for stocking the part at air base level. This analysis is related to the supply improvement program, initiated at Strategic Air Command, for reducing the number of spare aircraft items with low demand retained at base level. 12 pp. Tables.

- **RM-1316 (AD 85489). A game of aiming and evasion.** R. P. Isaacs and S. Karlin. 8-6-54. Unclassified.

An example of an evasion game, for which are presented the value of the game, the optimal strategy of the evader, and a proof that the marksman has no optimal strategy. 15 pp.

- **RM-1317 (AD 85490). Notes on the analysis of "immersed" variance.** J. W. Tukey. 8-9-54. Unclassified.

A technique for studying the variance of a concealed parameter. In particular, the case is examined where the variance components, associated with the parameter, are emphasized. 34 pp.

- **RM-1318 (AD 86840).** On the minimization of $\int_0^T |1 - x(t)| dt$. R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 8-12-54. Unclassified.

A solution of a minimization problem by converting the problem into one requiring a min-max and using the fundamental theorem of game theory. 4 pp.

- **RM-1320 (AD 85981).** Games with information lag. H. Scarf and L. S. Shapley. 8-10-54. Unclassified.

A study to determine a set of conditions for the existence of a value and optimal strategies for a two-person game in which each player has a denumerable sequence of choices to make. 7 pp.

RM-1321 (AD 85982). Statistical theory of navigation employing independent inertial and velocity measurements: minimum rms error in computed position. P. Swerling and E. Reich. 8-17-54. Unclassified.

A continuation of RM-1220, *Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements*. The present study gives (1) explicit formulas for minimum rms error in computed position as a function of time of flight and (2) curves based on these formulas to determine the results for numerous illustrative cases. 26 pp. Illus.

- **RM-1325 (AD 85984).** The compressibility of organizations and economic systems. Oskar Morgenstern. 8-17-54. Unclassified.

An attempt to distinguish essential and nonessential activities within an economic system or organization. This investigation assumes that the system will operate defectively if the nonessential activities cease, but will collapse unless the essential activities are performed. 20 pp.

- **RM-1326 (AD 85985).** Continuous iteration method for solution of differential games. John Nash. 8-18-54. Unclassified.

An iterative method for solving such differential games as simple air war games. This method is stated in a continuous form, but may be applied in a discrete approximation for use with a high-speed digital computing machine. 8 pp.

- **RM-1328 (AD 90503).** Notes on linear programming—part XV: minimizing the number of carriers to meet a fixed schedule. G. B. Dantzig and D. R. Fulkerson. 8-24-54. Unclassified.

A proof that the problem of determining the minimum number of carriers required to meet a fixed schedule of transportation can be made into a linear programming problem. 12 pp. Illus. Also published as P-569.

RM-1331 (AD 85986). Changing Japanese attitudes toward atomic weapons. A. M. Halpern. 9-1-54. Unclassified.

An investigation of the development of Japanese attitudes toward atomic weapons and other atomic-energy problems, especially as affected by recent events (up to mid-August, 1954). This study examines the background of the atomic bomb, the Bikini incident, and its effects on Japanese-American relations. 68 pp.

- **RM-1334 (AD 85988).** The effects of reversed thrust on landing distance. C. C. Kelber. 10-15-54. Unclassified.

An estimate of the effects upon jet aircraft landing distances for any combination of reverse-thrust effectiveness, aircraft landing weight, installed thrust, and average braking coefficient of friction. High-powered supersonic aircraft are examined under similar circumstances. 10 pp. Illus.

- **RM-1335 (AD 85989).** Optimal tactics in a multistrike air campaign. Melvin Dresher. 10-7-54. Unclassified.

An analysis of a tactical air campaign model, consisting of a finite number of counterair and countersurface missions, as a multimove continuous game. The optimal tactics are derived as a function of the attrition parameters. 17 pp. Table.

- **RM-1336 (AD 85990). On the computational solution of some functional equations in the theory of dynamic programming.** R. E. Bellman. 9-9-54. Unclassified.

A proof that various functional equations, occurring in the theory of optimal inventory and allocation, may be solved by simple iterative processes under certain conditions. 6 pp.

- **RM-1337 (AD 86021). On multi-stage games with imprecise payoff.** R. E. Bellman. 9-9-54. Unclassified.

A proof that under certain natural conditions the play of a multi-stage game is to a great extent independent of the payoff function. 6 pp.

- RM-1338 (AD 86022) (not available). Analytic formulation of a theater air-ground warfare system (1953 techniques).** C. P. Siska, L. A. Giamboni, and J. R. Lind. 9-13-54. Unclassified.

An attempt to determine the interactions of opposing tactical air and ground forces and the resultant effect on the movement of a main resistance line by studying a set of differential equations. These have been programmed on a Reeves Electronic Analogue Computer (REAC), so that a tactical theater war game may be simulated. 54 pp. Illus. See also RM-1428.

- **RM-1341 (AD 86024). On the solution of an approximate equation in the theory of optimal allocation.** D. R. Anderson. 9-14-54. Unclassified.

A discussion of a certain functional equation, the solution of which is useful in approximating to the solution of a more general functional equation. 13 pp.

- **RM-1342 (AD 86025). Proposal for the development of a theory of economic growth for a Soviet-type economy.** Harvey Leibenstein. 9-15-54. Unclassified.

A proposal which outlines (1) the general structure of a theory of Soviet economic growth, (2) the factors, variables, and relationships considered, and (3) the role and meaning of the interest rate for resource allocation under different dictatorial objective functions. 61 pp. See also P-808.

- Ø **RM-1344-AEC (AD 111053). Equation of state of air on the statistical model.** Richard Latter. 9-21-54. Unclassified.

An estimate of the equation of state (for an oxygen, nitrogen, and argon mixture occurring in air) for the temperature range from 5000°K upward and for densities from 1/2,000 to 50 times normal density. These results are compared with those of Bethe, Fuchs, and others. 35 pp. Illus.

- **RM-1351 (AD 86027). Note on the effect of circulation in heat transfer.** J. D. Cole. 9-24-54. Unclassified.

A discussion of the aerodynamic heating of blunt bodies at hypersonic speeds, together with the tendency toward laminar separation. The recirculating or vortexlike motion below the separated flow is described. Several cases of heat transfer in the presence of circulation are examined in order to determine various parameters and estimates of the circulation effect. 7 pp.

- RM-1357 (AD 86028). Confidence intervals for Poisson parameters in logistics research.** J. W. T. Youngs, M. A. Geisler, and A. R. Mirkovich. 9-30-54. Unclassified.

A presentation of (1) the method of confidence intervals for Poisson parameters and (2) some tables for estimating the confidence intervals for useful Poisson distribution values. Such data help to determine the demand pattern at air base level for each of, or a sum of, many types of supply items. 8 pp. Table.

- **RM-1359 (AD 86030). Computation of radiation level in the vicinity of a distribution of contaminating material.** R. H. Frick. 9-30-54. Unclassified.

A solution for the radiation level in the vicinity of various distributions of radioactive material. This study helps to determine the degree of radiation hazard and the effectiveness of certain decontamination techniques. 29 pp. Illus.

RM-1360 (AD 86391). The desirability of revising Aircraft Form 1. R. S. La Vallee. 10-1-54. Unclassified.

A proposal that the Air Force reporting system be redesigned. This study discusses a possible new system, the additional information obtainable from the revision, and the effort required to make any new system feasible and practical. 27 pp. Illus.

- **RM-1361 (AD 86392). Parallel control.** J. F. Nash. 8-27-54. Unclassified.

A discussion of the advantages of a new control-system design for high-speed digital computers. The control considered is decentralized by different units, capable of directing various simultaneous operations and interrelating them correctly. 15 pp. Illus.

RM-1363-AEC (AD 86951). Numerical solutions of spherical blast waves. H. L. Brode. 9-29-54. Unclassified.

An attempt to solve the problem of a spherical blast in air by employing an artificial viscosity as a mechanism for avoiding shock-front discontinuities. This study considers overpressure, density, particle velocity, and position as functions of time and space. In addition, dynamic pressure, static overpressure, durations of pressure and velocity, and shock values of all quantities are described for various times and radial distances. 35 pp. Illus.

- **RM-1367 (AD 111054). Notes on linear programming—parts VIII, IX, and X: upper bounds, secondary constraints, and block triangularity in linear programming.** G. B. Dantzig. 10-4-54. Unclassified.

An attempt to develop short-cut computational methods for solving systems whose matrices may be described as block triangular. 22 pp. Also published as P-576.

- **RM-1368 (AD 86393). On the convergence of discrete stochastic decision processes to their continuous analogues.** H. A. Osborn. 11-8-54. Unclassified.

A direct proof of the convergence of the discrete gold-mining process to the continuous process discussed in P-433, *A Functional Equation in the Theory of Dynamic Programming and Its Generalizations*, and R-271, *Dynamic Programming of Continuous Processes*. 25 pp. See also Part II, RM-1414.

- **RM-1369 (AD 90504). Notes on linear programming—part XVI: the problem of routing aircraft—a mathematical solution.** A. R. Ferguson and G. B. Dantzig. 9-1-54. Unclassified.

An application of linear programming to a transportation problem in which a method is presented for assigning a given fleet of various aircraft types to carry an anticipated traffic load over several routes at minimum cost. 18 pp. Tables. Also published as P-561.

- **RM-1370 (AD 90505). Functional equations, Wiener integrals and applications—I: functional equations.** R. E. Bellman. 11-10-54. Unclassified.

The first of a series which shows that functional equations and ultimately partial differential equations may be determined for various Wiener integrals as functions of suitably introduced parameters. This study illustrates the basic approach by deriving the analytic equivalent of the central limit theorem. 6 pp.

- **RM-1372 (AD 86394). Some German press views on the defense of Europe: a survey of West German press opinion on military aspects of the defense of Europe.** E. W. Schnitzer. 11-26-54. Unclassified.

A survey of West German writings, which appeared from December, 1953, to May, 1954, concerning deterrents to war, factors making war more likely, unconventional weapons, anxieties related to European defense, and images of future war. 80 pp.

- **RM-1373 (AD 86395). A summary of *Recent thought in Sweden on Western defense* by James J. Robbins.** E. W. Schnitzer. 11-26-54. Unclassified.

A summary of James J. Robbins' book, *Recent Thought in Sweden on Western Defense*. The writings considered, which are those of Swedish military commentators, discuss the strategic position of Sweden, air power and the influence of nuclear weapons, and various problems concerning Swedish and Western European defense. 21 pp. A condensation of RM-1407.

- **RM-1374. Notes on linear programming—part XVII: linear programming under uncertainty.** G. B. Dantzig. 11-16-54. Unclassified.

A study of a class of linear programming models where the activities are divided into two or more stages. The quantities of activities in the first stage are determined in advance, and those in the second and later stages are dependent on the outcome of random events. 19 pp. Also published as P-596.

- **RM-1375 (AD 86396). Notes on linear programming—part XVIII: status of solution of large-scale linear-programming problems.** G. B. Dantzig. 11-30-54. Unclassified.

A discussion of the need to compute large-scale systems of linear-programming problems. Various characteristics of some practical models, promising to lead to short-cut procedures, are indicated. 10 pp.

- **RM-1377 (AD 144274). The influence of a variable atmosphere on the blast from a high burst.** H. L. Brode. 11-17-54. Unclassified.

A comparison of the blast effects at the ground from a large bomb burst at high altitude with comparable bursts at sea level. In particular, a ten-megaton burst at 10,000 feet is considered. 20 pp. Illus.

- **RM-1379 (AD 86397). Optimization in dynamic allocation problems by a modified calculus of variations technique.** A. S. Mengel. 9-20-54. Unclassified.

A direct proof that modified Euler equations solve linear-type problems that can not be optimized by the classical calculus of variations technique. The method considered applies to nonlinear equations as well as to minimax problems if a saddle-point exists. 14 pp.

- **RM-1380 (AD 86398). Cargo density and air transportation.** R. E. Bickner. 5-10-55. Unclassified.

An attempt to improve the efficiency of airlift operations by examining (1) the significance of cargo densities in the various phases of airlift operations, (2) the mistakes resulting from the assumption that densities are constant, and (3) the methods by which cargo densities can be appropriately considered. 66 pp. Illus. See condensed version P-724. See also RM-1853.

- **RM-1383 (AD 90494). Notes on linear programming—part XIX: the fixed-charge problem.** W. M. Hirsch and G. B. Dantzig. 12-1-54. Unclassified.

A discussion of the properties of a general solution to a fundamental unsolved problem in the programming area. This problem is one in which various activities have fixed charges (e.g., set-up time charges) if operating at a positive level. 21 pp. Also published as P-648.

- **RM-1384 (AD 86399). Simple games: an outline of the descriptive theory.** L. S. Shapley. 11-23-54. Unclassified.

An attempt to determine the significant structural properties of simple games. These are defined as n -person games in which each coalition either wins outright or is completely impotent. A table of all simple games with four, or fewer, players is presented. 16 pp. Illus. See later version P-2277.

- **RM-1385 (AD 86400). A game of aiming and evasion: general discussion and the marksman's strategies.** R. P. Isaacs. 11-24-54. Unclassified.

A discussion of the general evasion game with a time lag in the information of the marksman as to the target position. An example is presented in which the marksman has no optimal strategy. 60 pp. Illus. See condensed version P-642.

- **RM-1386 (AD 86481). On the continuous simplex method.** R. S. Lehman. 12-1-54. Unclassified.

A study which develops the continuous simplex method and applies it to several bottleneck problems. This method is defined as a systematic technique for solving a class of problems arising in the dynamic programming theory. 57 pp.

- **RM-1391 (AD 90493). Differential games—I: introduction.** R. P. Isaacs. 11-30-54. Unclassified.

A discussion of the general scope and applications of differential games. The basic concepts are presented in terms of such military applications as pursuit, battle, and aiming games. 33 pp. Illus. See also RM-1399, RM-1411, and RM-1486.

- RM-1392 (AD 86482). The cost of various base stocking and requisitioning policies for aircraft spare parts.** J. W. Petersen and M. A. Geisler. 12-8-54. Unclassified.

An analysis of air base stocking and requisitioning procedures in which (1) the supply support available to the base is constant and (2) a criterion for the best combination of supply factors is the relative cost of supporting each simulated system. Support cost is assumed to be limited to the resupply cost, defined as all expenditures incurred from the time a requisition is prepared at base to the issue of the item to the using activity. 57 pp. Illus. See condensed version P-611.

- **RM-1399 (AD 90492). Differential games—II: the definition and formulation.** R. P. Isaacs. 11-30-54. Unclassified.

A continuation of RM-1391, *Differential Games—I: Introduction*. The present study examines the mathematical definition and concept of a differential game. 31 pp. Illus. See also RM-1411 and RM-1486.

- **RM-1400 (AD 90541). Notes on linear programming—part XX: maximal flow through a network.** L. R. Ford, Jr., and D. R. Fulkerson. 11-19-54. Unclassified.

A proof of the minimal cut theorem, for a general network, which determines a simple computational procedure for achieving a maximal flow in planar networks. 12 pp. Also published as P-605.

- **RM-1401 (AD 90510). The strength of anchor bolts set in concrete.** C. A. Sandoval. 11-24-54. Unclassified.

A review of available data on the strength of anchor bolts set in concrete in order to determine the actual structural behavior of the anchorages. Only anchor bolts with heads and straight or hooked bars are considered. 20 pp. Illus.

- RM-1402 (AD 86486). A summary of some base supply activity and workload reports.** J. W. Petersen and M. A. Geisler. 12-29-54. Unclassified.

A summary of air base supply activity at twenty-nine bases, all but one of which are located in the United States. An attempt is made to estimate the supply workload of a typical base as part of a broader investigation to improve the processing of supply data within the Air Force. 19 pp. Tables.

- Ø ● **RM-1403-8 (AD 265335). A selected list of unclassified publications of the Social Science Department, The RAND Corporation, 1948–1961.** Social Science Department. Revised Periodically. Unclassified.

- **RM-1407 (AD 86489). Recent military thought in Sweden on Western defense.** J. J. Robbins. 1-25-55. Unclassified.

An analysis of the writings of Swedish military commentators dealing with (1) the strategic position of Sweden, (2) air power and the influence of nuclear weapons, and (3) other problems concerning Swedish and Western European defense. Memorandum RM-1373 is a condensation of this fuller treatment. 230 pp.

- **RM-1409 (AD 86490). On maximizing an inner product.** W. H. Fleming. 1-11-55. Unclassified.

A solution to the problem of maximizing the inner product of a fixed continuous positive function, defined on the unit interval with a variable function. 11 pp. Illus.

- **RM-1411 (AD 90509). Differential games—III: the basic principles of the solution process.** R. P. Isaacs. 12-12-54. Unclassified.

A discussion of (1) the differential equation technique for solving differential games and (2) the verification theorem for proving that the answers obtained are the correct solutions. 21 pp. See also RM-1391, RM-1399, and RM-1486.

- **RM-1412-AEC (AD 86701). Effect of correlations on the equation of state of an electron gas.** R. A. Ferrell. 1-14-55. Unclassified.

An attempt to apply quantitatively the equation of state of a free electron gas to relatively low temperatures in order to emphasize correlation effects. 14 pp. Illus.

- **RM-1413 (AD 86702). The prediction of demand for aircraft spare parts using the method of conditional probabilities.** J. W. T. Youngs, M. A. Geisler, and B. B. Brown. 1-17-55. Unclassified.

A technique for predicting future demand (or consumption) of individual aircraft spare items on the basis of number of aircraft-months. This prediction technique is based on the method of conditional probabilities and the negative binomial distribution. 39 pp. Tables.

- **RM-1414 (AD 87964). On the convergence of discrete stochastic decision processes to their continuous analogues—II.** H. A. Osborn. 12-19-55. Unclassified.

A proof that the continuous versions of large classes of dynamic programming processes are the rigorous limits of the corresponding discrete versions. The discrete versions are not assumed to consist of equally spaced decisions. 18 pp. See also Part I, RM-1368.

- **RM-1415 (AD 86703). A two-machine-gun duel with the bomber turret vulnerable.** F. P. Ballantyne. 12-7-54. Unclassified.

An analysis of a two-machine-gun duel in which the sole motive of the fighter is to kill the bomber and the goal of the bomber is survival. It is assumed that the bomber defends itself with a tail turret and that the fighter, bomber, and bomber turret are each considered a singly vulnerable area. 12 pp.

- **RM-1416-AEC (AD 86711). Atomic energy levels for the Thomas-Fermi and Thomas-Fermi-Dirac potential.** Richard Latter. 10-19-54. Unclassified.

A study to determine the Schrödinger equation for the Thomas-Fermi and Thomas-Fermi-Dirac potentials. Electron self-interactions are considered by modifying the potentials to give asymptotically the field of a unit charge, and all levels from 1s to 7d are examined for a range of Z-values sufficient to permit easy interpolation. 32 pp. Illus.

- **RM-1417 (AD 86704). A proposal for a new Air Force supply procedure.** R. B. McNeill, E. B. Berman, A. J. Clark, and H. W. Nelson. 1-24-55. Unclassified.

Part of a broader investigation to determine the ways in which Air Force supply procedures might be revised in order to exploit the potentialities of present and prospective electronic data processors. The present study proposes a plan which (1) is designed to produce a current status of worldwide inventory assets by line item by stockage location and (2) involves the mass processing of the day-to-day supply activities paperwork on a large-scale electronic data handling computer at various central record keeping points. 89 pp. Illus. See also RM-1639-1, RM-2013, RM-2232, and RM-2269.

- **RM-1418. Notes on linear programming—part XXI: on the max flow min cut theorem of networks.** G. B. Dantzig and D. R. Fulkerson. 1-1-55. Unclassified.

A proof that the theorem of Menger and the Min Cut Max Flow Theorem on networks are an application of the duality theorem of the linear inequality theory. 12 pp. Also published as P-826.

- **RM-1420-AEC (AD 86706). Solutions of the temperature-perturbed Thomas-Fermi equation.** J. J. Gilvarry and G. H. Peebles. 11-5-54. Unclassified.

An analytical solution of the temperature-perturbed Thomas-Fermi equation in order to determine boundary and initial parameters, corresponding to seven neutral-atomic zero-temperature solutions given by Slater and Krutter. An extension in directly-fitted range is presented, and the effects of the temperature perturbation on the equation of state are shown graphically for this extended range. 17 pp. Illus.

- **RM-1421 (AD 86707). Prices of fuelwood and wood products in the USSR, 1928–1950.** Roman Bernaut (under the supervision of Abram Bergson). 2-1-55. Unclassified.

Part of a broader investigation to provide a basis for calculating rates of change in the output of various sectors of the Russian economy. The present study examines wood prices in the USSR from 1928 to 1950. 90 pp. Tables.

- **RM-1423 (AD 90508). Prices of coal and peat in the Soviet Union, 1928–1950.** E. L. Turgeon (under the supervision of Abram Bergson). 2-2-55. Unclassified.

Part of a broader investigation to provide a basis for calculating the dollar equivalent of current Russian industrial and military output. The present study considers coal and peat prices in the Soviet Union from 1928 to 1950. 82 pp. Tables.

- RM-1428 (AD 86709). Narrative description of an analytic theater air-ground warfare system.** J. R. Brom. 2-10-55. Unclassified.

A discussion of the theater war formulated in the tactical air-ground study. The present analysis considers the detail inherent in the mathematical model and the relationships of the technique to the over-all planning problem. In addition, air, ground, and logistic network operations are examined, together with the nature, functions, and simulated performance of the forces. 29 pp. See also RM-1338.

- **RM-1430 (AD 86710). A resource allocation problem in continuous form.** W. H. Fleming. 2-16-55. Unclassified.

A study to determine the solution of a simple optimal resource allocation problem by considering the general methods developed in P-639, *Variational Problems with Constraints*. 19 pp. Illus.

- RM-1431 (AD 86712). Analysis of base stockage policies.** M. A. Geisler. 2-17-55. Unclassified.

A study of (1) the characteristics of demand for spare parts at base level using B-47 experience as the data source, and (2) the effect of such characteristics upon Air Force Manual 67-1 stock-control procedures and policies and of alternative policies upon base supply performance and costs. 30 pp. Illus.

- **RM-1432 (AD 90506). Notes on linear programming—part XXIII: a production smoothing problem.** S. M. Johnson and G. B. Dantzig. 1-6-55. Unclassified.

An attempt to determine a production schedule for a single type item over numerous time periods in order to satisfy a given requirement schedule while minimizing total cost. It is assumed that the costs per unit for production, storage, and change in production rate are known functions of time. 28 pp. Illus. Also published as P-610.

- **RM-1433 (AD 90542). Background, development, and extensions of the revised simplex method.** William Orchard-Hays. 4-30-54. Unclassified.

A discussion of the development of the present form of the simplex method, as used in the RAND codes for the IBM 701 calculator. In addition, some results of computational experience are given, and numerous parametric variations are examined. 66 pp. Illus.

- **RM-1434-RC. Bargaining: the hidden hand in government.** C. E. Lindblom. 2-22-55. Unclassified.

An analysis of bargaining in government as a preferable method of decisionmaking which results in the public interest. In addition, the distinction between bargaining and hierarchy in government is discussed. 46 pp.

- **RM-1435 (AD 86713). A similarity solution for a spherical shock wave.** Richard Latter. 2-3-55. Unclassified.

A proof (using the viscosity technique) that in the limit of infinite shock strength, a point-source spherical shock flow has a similarity solution for a γ -law gas. The solution considered is determined by the numerical and analytic integration of the ordinary differential equations resulting from the similarity of the flow. 26 pp. Tables. Also published as P-633.

- **RM-1438 (AD 86717). The optimization of quadratic functions subject to linear constraints.** H. M. Markowitz. 2-21-55. Unclassified.

A computing technique for generating several efficient sets of combinations of the expected value, and the variance of the payoff. While this study discusses only minimization problems involving a quadratic form whose matrix is positive semidefinite, this technique may be adapted for problems of maximizing or minimizing quadratic forms (with the right properties) subject to linear constraints. 30 pp. Illus. Also published as P-637.

- **RM-1439 (AD 86719). A comparison of the FFA and RAND methods of fatigue analysis.** F. R. Shanley. 3-1-55. Unclassified.

A study concerning the development of a method, proposed as a basis for improved airworthiness requirements, which analyzes the structure for repeated loads. A comparison is made between the essential features of the FFA method (presented by Mr. B. Lundberg at the 18th Wright Brothers Lecture) and the RAND method (given in RM-1127, *Fatigue Analysis of Aircraft Structures*). 23 pp. Illus.

- **RM-1440 (AD 86718). Notes on linear programming—part VI: the RAND code for the simplex method (SX4) (for the IBM 701 electronic computer).** William Orchard-Hays. 2-7-55. Unclassified.

A description of the fourth in a series of codes for the IBM 701 computer which perform the simplex method. While several modifications of the basic simplex procedure are given, only the code, as assembled for the revised simplex method on a primal system as opposed to its dual, is considered. 79 pp. Illus.

- **RM-1441 (AD 86720). Stalin and the uses of psychology.** R. C. Tucker. 3-10-55. Unclassified.

A survey of the background and development of the Russian Pavlovian revival, based on Soviet scientific discussions and theoretical journals. The author attempts to show that the new Pavlovianism occurs from "transformism" and is utilized by the Russians as a scientific technique of mind control and as an effective political weapon. 102 pp. See condensed version P-815.

- **RM-1442 (AD 86952). Responses to material presented during various levels of sleep.** C. W. Simon and W. H. Emmons. 12-27-54. Unclassified.

A description of an experiment designed to determine the effect on recall and response to material presented to subjects at various levels of awareness between wakefulness and deep sleep. 59 pp. Illus. See revised version P-618. See also RM-1444.

- **RM-1443 (AD 91181). A comparison of 1950 wholesale prices in Soviet and American industry.** N. M. Kaplan and W. L. White. 5-1-55. Unclassified.

An investigation of the data, sources, and methods required to compile price ratios for approximately 2000 commodities produced in the U.S. and USSR. This comparison of ruble-dollar wholesale prices may serve as an aid in obtaining information on the Soviet economy and on international price index numbers. 356 pp. Illus. See also RM-1986 and RM-2432.

- **RM-1444 (AD 86953). The nonrecall of material presented during sleep.** W. H. Emmons and C. W. Simon. 12-27-54. Unclassified.

A supplement to RM-1442, *Responses to Material Presented during Various Levels of Sleep*. The present study emphasizes repetitive training during which it is assumed that the subject is asleep and the material presented under these conditions is not recalled. 12 pp. Table. Also published as P-619.

- **RM-1446-AEC (AD 86954). The Lindemann and Grüneisen laws.** J. J. Gilvarry. 3-23-55. Unclassified.

A proof that the Lindemann fusion law can be derived from the theory of the temperature dependence of Bragg reflection of X rays. This law together with the Grüneisen theory of solids is used in order to determine the Grüneisen constant of the solid at melting in terms of fusion parameters. 32 pp. Illus.

RM-1447-AEC (AD 86955). Stark fields from ions in a plasma. A. A. Broyles. 3-28-55. Unclassified.

A method to determine the probability of obtaining a given electric field on an ion in a plasma. This quantity is essential for computing the broadening of spectral lines from neighboring ions and for their contribution to the opacity. 23 pp. Illus.

- RM-1452 (AD 86956). Notes on linear programming—part XXV: the elimination form of the inverse and its application to linear programming. H. M. Markowitz. 4-8-55. Unclassified.

A discussion of a particular product form of matrix inverse which is closely related to the Gaussian elimination method of solving a set of simultaneous equations. 19 pp. Tables. Also published as P-680.

- ● RM-1453-AEC (AD 99300). Relativistic and nonrelativistic energy levels in uranium. Richard Latter. 3-29-55. Unclassified.

A method for computing the relativistic and nonrelativistic energy levels in uranium. The eigenvalues obtained in the statistical potentials with the Hartree energies and the experimental energy levels are compared. In addition, the energy levels for large atomic numbers are obtained in the Thomas-Fermi potential using both the Schrödinger and Dirac equations. 8 pp. Illus.

RM-1457-AEC (AD 86958). Grüneisen's law and the fusion curve at high pressure. J. J. Gilvarry. 4-11-55. Unclassified.

A method which determines the corrections, corresponding to the lattice contributions, in thermodynamic functions obtained from the Thomas-Fermi model. It is assumed that the lattice contribution to the pressure is small and that the equation of state of the solid can be approximated by results of the statistical Thomas-Fermi atom model for the electron pressure. 30 pp. Illus.

- RM-1459 (AD 86959). Scientific satellite-payload considerations. B. W. Augenstein. 4-8-55. Unclassified.

An attempt to determine the kinds of equipment to be installed in a satellite vehicle, designed for scientific research and capable of carrying a limited instrument payload. The possible weights and power requirements of the necessary items are estimated, and the performance of representative payload combinations is investigated for various duty cycles. 12 pp. Tables.

- RM-1470 (AD 90543). Notes on linear programming—part XXIV: the modification of the right-hand side of a linear programming problem. H. M. Markowitz. 4-20-55. Unclassified.

A method to determine in one iteration a basic feasible solution in the simplex method for solving linear programming problems when the right-hand side of an equation is altered. 4 pp.

- RM-1474 (AD 87162). The value of American manufacturing plant and equipment. R. N. Grosse. 4-28-55. Unclassified.

An estimate (expressed in 1947 prices) of the stock of U.S. manufacturing plant and equipment. This study lists the capital requirements for a new plant in terms of equipment and structures required per dollar of annual capacity increase in the manufacturing industries examined, the replacement value of the capital goods in these industries, and the estimates considered which represent the maximum capacity as of the beginning of 1954. 42 pp. Tables.

RM-1475 (AD 111056). Notes on linear programming—part XXII: recent advances in linear programming. G. B. Dantzig. 4-12-55. Unclassified.

A discussion of such developments in linear programming as uncertainty, combinatorial problems, and large-scale systems. 31 pp. Also published as P-652.

- RM-1476 (AD 87163). A proposed mechanism of fatigue failure. F. R. Shanley. 4-11-55. Unclassified.

A description of a proposed mechanism of unbonding during reversed slip in order to determine what causes cracking to occur under repeated loading. 19 pp. Illus. Also published as P-666.

- **RM-1479 (AD 90544). Industrial training in the Soviet Union.** Walter Galenson. 5-5-55. Unclassified.

A discussion of Soviet vocational training since 1921. In particular, this study considers the magnitude of the industrial training program, the forms of direct factory training, the formal vocational education, and the dissemination of technical information within the USSR. 42 pp. Tables. Also published as P-729.

- **RM-1480 (AD 87164). The convergence of the discrete analogues of differential games: part I.** H. E. Scarf. 3-18-55. Unclassified.

An examination of a class of survival games in an arbitrary n -dimensional region R and with an arbitrary payoff function $f(x)$ on the boundary. It is assumed that the players cannot force the state of the game to proceed in any direction. 17 pp.

- **RM-1482 (AD 90549). Prices of miscellaneous basic industrial products, USSR, 1928-1950.** E. L. Turgeon, R. Bernaut, and A. Bergson. 5-9-55. Unclassified.

A study of wholesale prices of miscellaneous basic industrial products in the USSR from 1928 to 1950. This is part of a broader investigation expected to provide a basis for estimating rates of change in the output of various sectors of the Soviet economy. 147 pp. Tables.

- **RM-1486 (AD 90547). Differential games—IV: mainly examples.** R. P. Isaacs. 3-25-55. Unclassified.

A presentation of abstract examples of differential games, together with simplified models of practical applications. 60 pp. Illus. See also RM-1391, RM-1399, and RM-1411.

- **RM-1487-AEC (AD 87173). Line broadening by electrons: the validity of simple theories.** R. E. Meyerott and H. Margenau. 5-9-55. Unclassified.

A comparison of the simple impact theories of line broadening by electrons with the detailed computations of Kivel, Bloom, and Margenau. 12 pp. Illus.

- **RM-1488 (AD 90419). Studies in the economics of transportation.** M. Beckmann, C. B. McGuire, and C. B. Winsten. 5-12-55. Unclassified.

A study of the efficient use of transportation systems with an emphasis on the effects of traffic congestion. This is part of a broader investigation to determine how the average waiting time and the extent of fluctuation in individual waiting times depend on the opportunities for servicing and on the amount and irregularity of the inflow of claimants for service. 347 pp. Published by the Yale University Press, New Haven, Connecticut, 1956. \$4.00.

- **RM-1489 (AD 90548). Notes on linear programming—part XXVI: computation of maximal flows in networks.** D. R. Fulkerson and G. B. Dantzig. 4-1-55. Unclassified.

A proposal of a simple computational method—based on the simplex algorithm of linear programming—to determine a maximal flow between two given points in a transportation network. 17 pp. Illus. Also published as P-677.

- RM-1490 (AD 87175). A preferred method for designing a flyaway kit.** H. W. Karr, M. A. Geisler, and B. B. Brown. 5-19-55. Unclassified.

A statistical method for designing a flyaway kit of limited weight which minimizes the average number of stockouts for a given total weight. In addition, several proposals for improving the data required for the flyaway kit computation are considered. 85 pp. Illus. (RM-1490 supplement withdrawn.) See also RM-2062 and RM-2233.

- **RM-1491 (AD 87176). Maximum angular accuracy of a pulsed search radar.** Peter Swerling. 5-20-55. Unclassified.

An investigation of the theoretical maximum accuracy with which the angular position of a target can be determined by a pulsed search radar. Operations performed on the received signal for estimating target angular position are discussed. In addition, the relation between the problem of target detection and that of estimating angular position is considered. 44 pp. Illus. Also published as P-745.

- ø • RM-1492-AEC (AD 87441). **Equation of state of water.** A. L. Latter and R. Latter. 5-23-55. Unclassified.

A generalization of the Fermi-Thomas model for application of mixtures. This study attempts to determine the equation of state of water up to pressure of 10,000 megabars and temperatures of several thousand electron-volts. 4 pp. Illus.

- ø RM-1496-AEC (AD 87442). **The equation of the fusion curve.** J. J. Gilvarry. 5-24-55. Unclassified.

A generalization of the Lindemann law, used in connection with the Murnaghan equation of state for a solid. A law of reduced states for fusion is derived which is valid for the case of classical excitation of the lattice vibrations at melting. 23 pp. Illus.

- RM-1497 (AD 90550). **Prices of refined petroleum products in the USSR, 1928-1950.** A. E. Nimitz (under the supervision of Abram Bergson). 5-26-55. Unclassified.

A summary of changes in Soviet wholesale prices of refined petroleum products from 1928 to 1950. This study is part of a broader investigation expected to provide a basis for calculating deflators for components of national income data in current rubles. 120 pp. Tables.

- RM-1498 (AD 87443). **On network theory.** J. T. Robacker. 5-26-55. Unclassified.
A treatment of the theory of networks, culminating in a proof of the Fulkerson-Ford Min-Cut Theorem. This study shows the relationship between the theory of connected graphs and the theory of flows through a network. 21 pp.

- RM-1500 (AD 87444). **Scientific use of an artificial satellite.** H. K. Kallmann and W. W. Kellogg. 6-8-55. Unclassified.

A discussion of the types of data obtainable from an artificial satellite, their practical applications to such fields as radar and communications, and the requirements for satellite orientation which are correlated with various types of observation. 36 pp. Illus. See condensed version P-733.

- RM-1501 (AD 87445). **Discrete approximations to some continuous dynamic programming processes.** W. H. Fleming. 6-2-55. Unclassified.

A proof of the convergence of discrete approximations to some continuous dynamic programming problems, analogous to the calculus of variations problems with inequality constraints. 10 pp.

- RM-1504 (AD 87447). **The maximization of an integral subject to constraints.** O. A. Gross and H. E. Scarf. 6-15-55. Unclassified.

A solution to the problem of determining the constrained maximum of a certain integral. 8 pp.

- RM-1505 (AD 87448). **Estimate of average atmospheric properties between 500 km and 1000 km.** H. K. Kallmann. 6-21-55. Unclassified.

An attempt to estimate the atmospheric densities at altitudes between 500 km and 1000 km. Different atmospheric models are examined under assumptions most likely to prevail at these altitudes. 16 pp. Illus.

- RM-1506-RC (AD 111057). **The politics of German business.** G. A. Almond. 6-20-55. Unclassified.

An analysis of the prevailing attitudes in the West German business community. The political influence of this group is considered together with their lack of civic responsibility and their pro-European attitude. In addition, the threat of Soviet pressure for their trade and the problems created for American foreign policy are discussed. This study is based on interviews conducted in mid-1954 with West German businessmen, officials of business organizations, and political leaders. 116 pp.

- RM-1508. **Some implications of "weapons system support" by AMC.** Stephen Enke. 6-27-55. Unclassified.

An evaluation of the weapons system support by the Air Materiel Command. Various proposals are discussed for improving the supply to mobile combat units and for reducing present depot concentrations of some property subclasses. 10 pp. Illus.

- **RM-1511-AEC. Abstract compendium on theoretical equation of state for solids.** C. P. Nash. 6-30-55. Unclassified.

A compendium of literature on the theoretical equation of state for solids. Part I considers nonmetals while Part II discusses the general lattice theory. 32 pp.

- **RM-1512 (AD 87449). An analysis of machine tool substitution possibilities.** A. J. Rowe and H. M. Markowitz. 6-30-55. Unclassified.

Data required for a process analysis of the metal working industry on an economy-wide scale. The conceptual framework of a machine tool substitution analysis is examined, together with the empirical problems encountered. In addition, the parameters of the model considered and related matter are estimated. 96 pp. Illus. See supplement RM-1549.

- **RM-1517 (AD 87542). Aerodynamic research facilities required for the development of moderate and long-range ballistic missiles.** Carl Gazley, Jr. 6-1-55. Unclassified.

An investigation of the needs and requirements of aerodynamic research at hypersonic velocities associated with ballistic missiles. This study recommends the use of current test facilities to initiate this research and the development of new test facilities to duplicate actual flight conditions. 16 pp. Illus.

- RM-1518 (AD 87543). A test program for obtaining basic data on creep-buckling strength of flat plate elements at elevated temperature.** W. R. Micks. 7-20-55. Unclassified.

A study to verify several methods for determining the creep-buckling failure of plate elements in compression. The data considered are the times-to-failure (times to reach a specified critical deflection) of flat plate elements of various width-thickness ratios. The range of variables investigated is limited to those of interest to the aircraft structural designer. 16 pp. Illus.

- RM-1519 (AD 87544). A model of the procurement-repair decision for a spare item.** E. B. Berman. 7-25-55. Unclassified.

A technique, based on the objective of maintaining a given combat capability for minimum cost, which determines procurement and depot repair requirements for airplane spares. This study may help to develop a tool for Air Force planners faced with making decisions on procurement, distribution, and repair scheduling of spare parts over the future. 112 pp. Illus.

- RM-1520. The criticality and some potentialities of "cavity reactors."** George Safonov. 7-17-55. Unclassified.

An attempt to determine a critical equation for reacting systems with cores of very low density, thermally fissionable material surrounded by a moderating reflector. The critical mass of cavity reactors which employ U^{235} , U^{233} , and Pu^{239} for fuel and D_2O , Be, and C for reflector is given as a function of core size. In addition, possible implications of cavity reactors are discussed. 23 pp. Illus. See abridged version RM-1835.

- **RM-1521 (AD 87545). Some experiments on the traveling-salesman problem.** J. T. Robacker. 7-28-55. Unclassified.

An investigation of the efficiency of the linear programming technique in solving the traveling-salesman problem. 23 pp. Illus.

- **RM-1522 (AD 87546). Basic industrial prices in the USSR, 1928-1950: twenty-five branch series and their aggregation.** A. Bergson, R. Bernaut, and L. Turgeon. 8-1-55. Unclassified.

An extension of previous investigations concerned with index numbers of prices for different branches of Soviet basic industry from 1928 to 1950. The present study is a compendium of these publications and aggregates the branch series into corresponding series for major industries and industry groups. 129 pp. Tables.

- **RM-1524 (AD 87547). Transient heat conduction in composite slabs for a heat flux varying exponentially with time.** C. Gazley, Jr., J. H. Huth, and M. C. Horn. 7-22-55. Unclassified.

Solutions for transient heat conduction into single and composite slabs exposed at one surface to a heating rate which increases exponentially with time. It is assumed that the material properties are independent of temperature and that the unheated face is effectively insulated. Comparisons are made with solutions for other types of heat-input functions, and examples are given for several materials. 30 pp. Illus.

- **RM-1526 (AD 87549). Discrete approximations to some differential games.** W. H. Fleming. 8-8-55. Unclassified.

A proof of the convergence of the values of time-discrete multistage games as the maximum time between successive moves shrinks to 0. It is assumed that the functional equation describing the limiting process has a continuously differentiable solution. 8 pp.

- **RM-1529 (AD 87711). Relative maxima in variational problems with inequality constraints.** W. H. Fleming. 5-25-55. Unclassified.

A study concerning the relative maxima for certain maximization problems similar to one-dimensional problems of the calculus of variations. Sufficient conditions for a strong relative maximum are proved by an appropriate modification of the classical notion of the field of extremals. 35 pp.

- **RM-1532 (AD 87712). Determination of the maximal steady-state flow of traffic through a railroad network.** A. W. Boldyreff. 8-5-55. Unclassified.

A method which estimates the maximal steady-state flow of traffic through a railway network by applying gaming techniques to certain classes of mathematical problems. 36 pp. Illus.

- **RM-1533 (AD 90553). A symmetric market game.** L. S. Shapley. 8-8-55. Unclassified.

A study which describes a family of solutions to an $(m + n)$ -person game and presents various significant properties of the general solutions. The game is interpreted heuristically as a symmetrical market. 23 pp. Illus.

- **RM-1537-AEC (AD 87714). Crystal structures and atomic volumes of the elements.** W. G. McMillan. 8-12-55. Unclassified.

Data on the crystal structures of the common modifications of the elements at zero pressure. 13 pp. Table.

- **RM-1539 (AD 87715). Simple distribution functions for inventory control.** William Hamburger. 8-17-55. Unclassified.

A description of (1) the distribution functions corresponding to a simple type of stock control formula and (2) the advantages of such a formula. Useful when demands are extremely erratic, these formulas may be tested by comparing the corresponding distribution functions with pertinent historical demand data. 14 pp. Illus.

- **RM-1541 (AD 87716). The effectiveness of alternative flyaway kits.** William Hamburger. 8-22-55. Unclassified.

An attempt to determine the effectiveness of alternative flyaway kits by comparing several methods of their selection. This comparison is limited to a single kit size, one definition of "best," and one set of circumstances. Such data are considered as the predictability of demands for spare parts, the amount of activity to be supported by the kit, and the demand-rate and weight of each spare part. 15 pp. Illus.

- **RM-1542 (AD 87717). Information in games with finite resources.** David Gale. 8-18-55. Unclassified.

A proof that, in games with finite resources, the uniform mixed strategy is optimal. Therefore, a player is not helped by knowing the strategies available to his opponent. 9 pp. Also published as P-861.

- Ø • RM-1543 (AD 84052). **Equilibrium composition and thermodynamic properties of air to 24,000°K.** F. R. Gilmore. 8-24-55. Unclassified.

Calculations on the composition, pressure, energy, and entropy of dry air at eleven temperatures between 1000 and 24,000°K and at eight densities between 10^{-6} and 10 times normal density. The ideal-gas internal energies and free energies of twenty-nine different molecules, atoms, and ions are discussed, and Hugoniot (shock wave) curves for air at various initial densities are considered. 69 pp. Illus. See supplement RM-2328. See also R-149 (out of print).

- RM-1548 (AD 87720). **The number of distinct cuts in a network.** D. O. Ellis and J. T. Robacker. 7-27-55. Unclassified.

Proofs that (1) for any integer $n \geq 2$ there is a network with n nodes having 2^{n-2} distinct cuts, (2) there is no network with n nodes having more than 2^{n-2} distinct cuts, and (3) the desired network with 2^{n-2} distinct cuts may be planar and irreducible in connection with its origin and terminal. 12 pp. Illus.

- RM-1549 (AD 87811). **A compendium of pressworking operations.** A. J. Rowe. 9-12-55. Unclassified.

A supplement to RM-1512, *An Analysis of Machine Tool Substitution Possibilities*. While both studies provide data required for a process analysis of the metal working industry on an economy-wide scale, the present investigation classifies pressworking equipment and its tasks and discusses the selection, operation, and characteristics of this equipment. 26 pp. Illus.

- RM-1551 (AD 116581). **Approximate values for the continuous absorption coefficient of air between 2 and 600 volts.** F. R. Gilmore and A. L. Latter. 8-24-55. Unclassified.

Calculations of the absorption coefficient of air due to free-free and bound-free (photoelectric) transitions over the temperature and density ranges of 2 to 600 volts and 10^{-4} to 10 times normal density. This study assumes dissociation of the air molecules into identical atoms each having an average atomic number (nuclear charge), $Z = 7.262$. 8 pp. Tables.

- RM-1552 (AD 90552). **Soviet agriculture since the September, 1953, reforms.** A. E. Nimitz. 9-15-55. Unclassified.

A discussion of the developments proposed after the 1953 Soviet agricultural reforms to reduce the importance of private production in total food supply. In particular, this study discusses USSR plans to increase the production of specific crops and to improve incentives and collective farm management. 191 pp. Tables.

- RM-1553 (AD 88670). **Notes on linear programming—part XXVII: Dilworth's theorem on partially ordered sets.** A. J. Hoffman and G. B. Dantzig. 8-26-55. Unclassified.

A description of a linear programming approach to the finite case of a theorem of Dilworth on the decomposition of a partially ordered set as a union of chains. It is demonstrated that the problem of finding the mutually unrelated elements is equivalent to the dual of that problem. 11 pp. Illus.

- RM-1554 (AD 87813). **Absorption coefficients of air from 6000°K to 18,000°K.** R. E. Meyerott. 9-9-55. Unclassified.

A study which may serve as an aid in radiation transport problems. Data on the absorption coefficients of air in the temperature range from 6000°K to 18,000°K are presented, and continuous and discrete contributions to the absorption of air in thermodynamic equilibrium are considered. 11 pp. Tables.

- Ø RM-1556-AEC (AD 87814). **The Grüneisen parameter for an Einstein solid and under finite strain.** J. J. Gilvarry. 9-26-55. Unclassified.

A study to determine the Grüneisen constant, as evaluated from the equation of state, for an Einstein solid. The presence of a state of finite hydrostatic pressure is considered by Murnaghan's theory of finite strain in order to determine the Grüneisen parameters on the Debye and Einstein models. 27 pp. Illus.

RM-1557 (AD 87815). Abbreviations for price handbooks used in RAND studies of the prices of Soviet basic industrial goods. Abram Bergson. 9-27-55. Unclassified.

A list of the abbreviations used in RAND studies on the prices of Soviet basic industrial goods, together with the titles of the price handbooks to which the abbreviations refer. 4 pp.

- RM-1560 (AD 90546). Notes on linear programming—part XXVIII: a simple linear-programming problem explicitly solvable in integers. O. A. Gross. 9-30-55. Unclassified.

A solution (by recursion formulas) of a simple linear minimization problem, involving a cycle set of inequalities. A modification of these formulas yields a solution in the case where the unknown variables are restricted to assume only integer values. 8 pp.

- RM-1561 (AD 87817). A study of the growth potential of agriculture of the USSR. D. G. Johnson. 10-3-55. Unclassified.

An investigation of the difficulties in expanding Soviet agricultural output, the possibilities for increasing the available supply of agricultural products, and the input savings and labor uses in USSR agriculture. 72 pp. Tables.

- RM-1564 (AD 92289). Automatic navigation aided by intermittent position fixes. Peter Swerling. 9-25-55. Unclassified.

An analysis of navigation systems which combine a continuous position reading with independently obtained intermittent position fixes. By combining the intermittent fixes with the continuous position reading, the optimum method of computing position and velocity is derived. The optimization criterion is essentially the minimization of rms error. 46 pp. Illus.

- RM-1567 (AD 87819). Recent trends in Soviet trade. Oleg Hoeffding. 10-10-55. Unclassified.

An attempt to determine whether the USSR has lately shown evidence of genuinely greater trade-mindedness than it displayed under Stalin. This study emphasizes Soviet trade with the West since 1953 and discusses briefly salient developments in bloc trade. 30 pp. Also published as P-739.

- RM-1570 (AD 87820). The prediction of sequences. D. H. Blackwell. 10-12-55. Unclassified.

An estimate of the short-term future behavior of a sequence in order to achieve a specified reliability against all possible sequences. 14 pp.

RM-1571 (AD 87881). The significance of major cycle variables on turbojet engine performance at Mach 3.0. L. R. Woodworth. 9-14-55. Unclassified.

A study of the effects of major cycle variables on turbojet engine performance at the operating condition of Mach 3.0. These effects (i.e., compressor pressure ratio, compressor and turbine efficiency, turbine inlet temperature, afterburner temperature, cooling air bleed, inlet water injection, and inlet ram recovery) are presented in terms of specific fuel consumption and specific thrust. 19 pp. Illus.

- ● RM-1574-AEC (AD 87882). The equation of state of water on the Thomas-Fermi model. A. L. Latter and R. Latter. 10-24-55. Unclassified.

Methods for extending the Thomas-Fermi model of a compressed atom to molecules or mixtures of the type ZZ'_n . These methods are applied to H_2O at zero temperature in order to determine (1) the pressure and internal energy as functions of the density, (2) the position of the protons relative to the oxygen nucleus, and (3) the electrostatic potential distribution within the molecule. 29 pp. Illus.

- RM-1575 (AD 87887). The Contextual Map. J. L. Kennedy. 10-24-55. Unclassified.

A description of the use of the "Contextual Map" as a tool for assisting decisionmakers in dealing with large, complex interacting system problems. The map is a display of information, prepared in such a way that the viewer may comprehend the totality of a complex problem before breaking it up into components. 9 pp. See revised version P-965.

- **RM-1578-AEC (AD 87883). Photoelectric K and L shell absorption coefficients for highly ionized atoms.** S. A. Moszkowski and R. E. Meyerott. 11-1-55. Unclassified.

A method for calculating numerical values of K and L shell photoelectric absorption coefficients (averaged over subshells) for highly ionized atoms. This study considers (1) the photoelectric effect for hydrogen-like atoms, (2) the absorption from atoms using the customary screening approximation, (3) the effect of screening on the form of the wave-functions, and (4) a comparison of the various methods described. 20 pp. Illus.

- RM-1583-1 (AD 144275). Close-in H-bomb effects.** H. L. Brode. 11-11-55. Rev. 2-3-56. Unclassified.

A study concerned with the damage due to blast, thermal, and nuclear radiations from an H-bomb in regions of greater intensity than have been previously considered important to military effects. The fact that some aspects of the nuclear explosion remain unchanged in quality and increase in intensity while other phenomena change their character is discussed. 32 pp. Illus.

- **RM-1590 (AD 87965). Best exploration for maximum is Fibonaccian.** S. M. Johnson. 11-18-55. Unclassified.

A solution to the problem of minimizing the number of calculations of values of the function in order to ensure the location of its maximum to a prescribed degree of accuracy. The discrete analogue of this problem involves the Fibonacci sequence. 7 pp. See revised version P-856.

- **RM-1592 (AD 87885). Steam locomotive availability and terminal facilities.** C. B. McGuire. 11-28-55. Unclassified.

A study to determine the daily availability of steam locomotives by examining the light maintenance and servicing work done in engine terminals, the locomotive time consumed in such work, and the equipment and labor required. This discussion may serve as an aid in such problems as (1) whether or not a steam railroad's activities are most easily stopped by destroying its facilities for locomotive maintenance and servicing and (2) estimating the capacity of foreign railroad systems for use in economic vulnerability and logistical interdiction studies. 30 pp. Illus.

- **RM-1598 (AD 87963). A condition for the existence of saddle-points.** L. S. Shapley. 9-14-55. Unclassified.

A study which relates the occurrence of saddle-points in zero-sum two-person games to their occurrence in subgames. 4 pp.

- **RM-1603 (AD 87962). A search problem due to Bellman.** O. A. Gross. 9-12-55. Unclassified.

A presentation of two interpretations of a general search problem posed by R. Bellman. Solutions are given in certain special cases. 9 pp. Illus.

- **RM-1604 (AD 90545). Notes on linear programming—part XXIX: a simple algorithm for finding maximal network flows and an application to the Hitchcock problem.** L. R. Ford, Jr., and D. R. Fulkerson. 12-29-55. Unclassified.

A solution for finding a maximal flow and minimal cut in a transportation network in order to determine an efficient computational routine for the Hitchcock distribution problem. 22 pp. Illus. Also published as P-743.

- **RM-1606 (AD 90551). A comparison of Soviet and United States retail prices for manufactured goods and services in 1950.** E. S. Wainstein. 1-5-56. Unclassified.

Part of a broader investigation expected to provide a basis for calculating the dollar equivalent of current Soviet industrial and military output. The present study compares Soviet and U.S. retail prices for manufactured goods and services in 1950. 111 pp. Tables.

- **RM-1612 (AD 87888). Allocating MATS equipment with the aid of linear programming.** A. S. Manne. 1-16-56. Unclassified.

A study concerned with the planning of Military Air Transport Service airlift operations. In par-

ticular, a procedure is examined for allocating transport equipment in an efficient way. The method is illustrated by numerous examples and can be applied in a straightforward mechanical fashion. 34 pp. Illus.

- **RM-1615 (AD 93456). Basic supersonic ramjet point-design performance.** G. B. W. Young. 12-5-55. Unclassified.

A study which may serve as an aid to propulsion engineers concerned with preliminary missile design in estimating ramjet performance. Thrust coefficients and specific impulses from Mach 1.3 to 5.0 are presented for a wide variation in engine component efficiencies. Hydrocarbon is the only fuel type considered. 53 pp. Illus.

- **RM-1621 (AD 87966). A technique for optimal distribution of available stocks to bases.** A. J. Clark. 1-30-56. Unclassified.

A technique for distributing available stocks of Air Force property among bases in an optimal fashion. The level of system stocks, the uncertainty of demand for parts, and the costs not only of holding and processing Air Force property, but also of the effects of a shortage of a part when it is needed are considered. The technique is particularly applicable to aircraft spare parts. 67 pp. Illus.

- **RM-1624 (AD 102054). Weight-feasibility calculation for shielding of truck passengers.** T. E. Harris. 2-3-56. Unclassified.

A proposal of a shielded structure as a protection against gamma radiation from fallout for passengers carried on trucks. The weight of shielding material required for a given degree of shielding is calculated on the basis of a roughly optimum distribution of the material. 24 pp. Illus.

- **RM-1632 (AD 95292). Expected damage from single and multiple bombs to targets distributed uniformly around a circle.** C. V. Sturdevant III. 2-9-56. Unclassified.

Curves showing the expected damage from single and multiple bomb drops to equal-valued point targets (e.g., aircraft shelters) distributed uniformly around a circle. The damage function utilized is 1.0 (complete damage) when the bomb falls within its lethal radius of the individual target and 0 (zero) when it falls outside this distance. The expected damage has been empirically maximized by suitably selecting aim points for the one-bomb case only. 21 pp. Illus.

- **RM-1633 (AD 93455). Newtonian flow theory for slender bodies.** J. D. Cole. 2-13-56. Unclassified.

An examination of the Newtonian flow theory from the viewpoint of gas dynamics and hypersonic small-disturbance theory. A general solution of the first approximation for the flow past slender bodies at zero angle of attack is given. This study may serve as an aid to the aerodynamicist in designing airframes for hypersonic speeds. 33 pp. Illus. Also published as P-926.

- **RM-1636 (AD 87889). Forces for change in Soviet society.** R. C. Tucker. 1-25-56. Unclassified.

A presentation of some tentative conclusions of recent research on trends of Soviet society and leadership since the death of Stalin. The reasons examined for the changes expected in the Soviet Union are (1) the failure of the population to respond to the goals of the Soviet state and (2) a restiveness of the managerial class which was so long kept impotent while Stalin was alive. 58 pp. Also published as P-1142.

- **RM-1637 (AD 89709). Red Star on military affairs, 1945-1952: a selected, annotated list of articles in the Soviet military newspaper.** Alexander Dallin. 2-10-56. Unclassified.

An annotated list of articles on military affairs appearing in the Russian military newspaper *Red Star*, compiled as an aid to those interested in recent discussions within the Soviet Union about the military implications and nuclear weapons. The period covered is July, 1945, to the end of 1952, shortly before Stalin's death. 49 pp.

- **RM-1638 (AD 92290). The role of the military in recent Soviet politics.** R. L. Garthoff. 3-1-56. Unclassified.

A study of the role of military issues and the part played by the senior military leaders in Soviet political developments since the death of Stalin in 1953. In particular, the policy differences between Malenkov and his supporters on the one hand and the Khrushchev faction on the other are emphasized. 89 pp. See revised version P-937.

- RM-1639-1 (AD 96903). Research and development of a new data-processing system for Air Force logistics.** M. A. Geisler and J. A. Postley. 2-20-56. Rev. 6-13-56. Unclassified.

A summary of RAND's work in logistics data processing and a proposed revision of the Air Force's data processing system designed for use in the 1960's. Several recommendations for implementing a system that combines weapon system and commodity management are presented: (1) adequate support for the ELECTRO LOGS project at the Oklahoma City Air Materiel Area, (2) establishment of a research and systems design office at Hq., Air Materiel Command, and (3) acceptance of the schedule outlined for data processing development. 65 pp. Illus. See also RM-1417, RM-2013, RM-2232, and RM-2269.

- RM-1640 (AD 92506). The relation of aircraft status data to the logistics system.** M. A. Geisler and A. R. Mirkovich. 2-21-56. Unclassified.

Part of a larger investigation concerned with techniques for allocating a given or fixed budget between weapons and logistics support in order to maximize combat effectiveness. This particular study summarizes statistical data on aircraft status and discusses their significance for research in logistics. The aircraft models considered (from July 1951 to June 1955) are B-47, F-86, F-84, F-89, F-80, and C-124. 59 pp. Illus.

- **RM-1641 (AD 92288). Graphical determination of ballistic trajectories: through outer space with compass and straightedge.** R. H. Frick. 2-24-56. Unclassified.

A method of solving the problem of the motion of a body under the influence of the earth's gravitational field for arbitrary boundary conditions on position, velocity, and path direction. It is assumed that (1) the earth is spherical, (2) the gravitational field follows an inverse square law, and (3) there is no atmosphere. 50 pp. Illus.

- **RM-1643 (AD 101072). On the problem of determining the position of a target with constant signal in the presence of circuit noise or chaff.** A. J. F. Siegert. 9-13-55. Unclassified.

A study dealing with the radar location of a target in one of m possible positions in the presence of circuit noise or chaff. Known as the " m -position experiment," the problem has been previously treated under certain restrictive assumptions, some of which have been removed for the purpose of this discussion. 19 pp.

- **RM-1644 (AD 90560). Notes on linear programming—part XXX: a class of discrete-type minimization problems.** O. A. Gross. 2-24-56. Unclassified.

A proof that a minimization problem involving a finite set of convex functions is solvable in nonnegative integers by means of a simple algorithm. A criterion is established for testing whether or not a feasible solution is optimal. Special applications are included. 13 pp.

- RM-1647 (AD 92501). A concept of mechanized transportation data processing.** A. J. Clark. 2-20-56. Unclassified.

A concept for data processing connected with the packaging, shipping, transportation, and receiving of materiel in the Air Force supply system. Methods are discussed for predesignation of transportation, control of materiel awaiting transportation, preparation of transportation documents, communication of transportation information, claims processing, traffic management, and the performance of other related functions. 51 pp. Illus.

- **RM-1650 (AD 92502). Approximate thermodynamic properties of compressed hydrogen gas from 5000° to 12,000°K.** F. R. Gilmore. 3-7-56. Unclassified.

Calculations on the equilibrium fraction of dissociated molecules, using published values for the ideal gas properties of H₂ and H. Hydrogen gas is considered at temperatures of 5000, 6000, 7000, 8000, 9000, 10,000, and 12,000°K and at densities of 25, 50, 100, 200, 400, and 800 times a particular standard density. In addition, the pressure, entropy, and enthalpy of the equilibrium mixture are determined. 8 pp. Illus.

- **RM-1652 (AD 100023). Optimal sequential testing.** S. M. Johnson. 3-15-56. Unclassified.

A discussion of the sequence in which components of a complicated machine should be tested and repaired in case of a breakdown in order to minimize the expected delay time. Some mathematical versions of the general problem and their solutions are presented. 12 pp.

- **RM-1654 (AD 98631). The influence of an aggressor's attack effectiveness upon the characteristics desired for a defender's air force.** C. V. Sturdevant III. 3-12-56. Unclassified.

A discussion of the influence of an aggressor's attack effectiveness on (1) the size of the defender's air force, (2) the proportion of the defender's budget to be spent for protective devices, and (3) the protective devices selected by the defender. 12 pp. Illus.

- **RM-1658 (AD 105534). The allocation of MATS airlift—January 1956: Pacific Ocean Area.** A. S. Manne. 3-21-56. Unclassified.

An application of linear programming techniques to the problem of assigning both Military Air Transport Service (MATS) and commercial equipment to individual airlift jobs in the Pacific Ocean Area in any one month. The problem considered is to specify trip frequency by route by type of aircraft, together with the amount of tonnage by route to be purchased from commercial carriers. 39 pp. Illus.

- **RM-1659 (AD 95138). Production of food crops in mainland China: prewar and postwar.** Chong Twanmo. 3-22-56. Unclassified.

The first of a series of studies concerned with agriculture production in prewar and postwar China in order to determine the accuracy of the output data released by the Communists since their seizure of the Chinese mainland in 1949. The statistics are given mainly in terms of the Chinese system of weights and measures. 84 pp. Illus.

- **RM-1660 (AD 92503). Min-max theorems on shortest chains and disjunct cuts of a network.** J. T. Robacker. 1-12-56. Unclassified.

A formulation of a theorem analogous to the minimum-cut, maximum-flow theorem of Fulkerson and Ford. The theorem relates the length of the shortest chain of the network to the maximum total flow through the class of cuts of the network. 8 pp.

- **RM-1664 (AD 107151). A brief investigation of the possibility of increasing the range of aircraft by dropping unnecessary parts in flight.** T. F. Kirkwood. 3-26-56. Unclassified.

An investigation of the increase in range obtained by designing an aircraft so that parts which have ceased to perform a useful function may be dropped in flight. A theoretical limiting case is studied, as well as more practical cases in which the landing gear is dropped after takeoff and non-lifting external fuel tanks are dropped when empty. 28 pp. Illus.

- **RM-1668-RC. Paris from EDC to WEU.** N. C. Leites and C. de la Malène. 3-1-56. Unclassified.

An attempt to analyze the attitudes of French parliamentarians on the problems of French foreign policy that were aroused by various schemes for German rearmament. These attitudes developed during the year preceding the French ratification of the Western European Union in March 1955. That year included such major events as the rejection of the European Defense Community, the acceptance of the London Agreements, and the passage of the Paris Agreements through the National Assembly. 210 pp.

- **RM-1669 (AD 93541). Estimate of pressure effects on NO-band lines.** Henry Margenau. 4-3-56. Unclassified.

An attempt to determine the expected widths of nitrogen oxide (NO). This study is based on the interactions responsible for the line widths, and correlations are used between these interactions and line widths in other confirmed instances. The forces considered are predominantly Van der Waals (dispersion) forces at large and repulsive exchange forces at small distances, since neither NO nor the perturbing molecules have appreciable dipole moments. 6 pp. Illus.

- **RM-1670-AEC (AD 95293). The validity of the statistical theory of pressure broadening.** Henry Margenau. 4-3-56. Unclassified.

A proof that (1) when a spectral line is broadened by single impacts of perturbing molecules and the half-width of the line is $\Delta\omega$, the statistical theory of broadening is applicable provided $\Delta\omega \cdot T \gg 1$, and (2) far in the wings of a line the statistical theory is always applicable. 7 pp. Illus.

- **RM-1673-RC. West German trade unions: their domestic and foreign policies.** Otto Kirchheimer. 4-1-56. Unclassified.

A survey of the historical, political, and organizational factors contributing to the present configuration of the German labor movement and to the formation of the centralized German Labor Federation. In addition, this study describes the structure of the unions, their attitudes concerning public issues, their relations with the government, and, in particular, the views of labor leaders on current foreign policy problems. 168 pp.

- **RM-1674 (AD 96016). Collective leadership and the political police in the Soviet Union.** E. Bernaut and M. J. Ruggles. 3-15-56. Unclassified.

An attempt to trace the evolution of the Russian political police since the establishment of the Soviet state. How the powers and functions of the police changed with shifts in the Communist policies is discussed, together with its role and probable development under the present collective leadership. 58 pp.

- **RM-1676-AEC. A catalog of fallout patterns.** S. M. Greenfield, R. R. Rapp, and P. A. Walters. 4-16-56. Unclassified.

A method for estimating quickly the fallout from a massive nuclear attack. This method consists of 26 carefully computed fallout patterns, together with instructions for matching them approximately to a given yield and wind condition. An outline of the basic computational model is given, and possible sources of errors of estimates are discussed. 94 pp. Illus.

- RM-1677. Vulnerability of fuel storage tanks to nuclear blast: response and scaling of floating roof tanks.** W. R. Elswick, L. A. Gore, and C. A. Sandoval. 4-18-56. Unclassified.

Part of a broader investigation concerned with the vulnerability of bulk fuel storage and the survival of Air Force weapon systems subject to nuclear attacks. The present study attempts to analyze the vulnerability of hard-shell, floating-roof, fuel-storage tanks to nuclear blast loading. The characteristics of the blast wave are idealized, there is no lag in the build-up of aerodynamic type loads, and the floating roof and liquid surface are assumed to remain a plane surface as they are forced to move by the blast pressures. 32 pp. Illus.

- **RM-1678 (AD 101071). An introduction to systems analysis.** M. W. Hoag. 4-18-56. Unclassified.

A speech on systems analysis which was delivered to an Air Force group visiting RAND. Systems analysis is defined as a systematic examination of a problem of choice in which each step of the analysis is made explicit wherever possible. In particular, the history of systems analysis and its application to military problems are discussed. 22 pp. Illus.

- **RM-1680 (AD 116583). Vulnerability of fuel storage tanks to nuclear blast: motion of liquid surface in an open rectangular tank.** L. A. Gore. 4-20-56. Unclassified.

An attempt (1) to determine the motion of the free liquid surface of a rectangular fuel storage tank subjected to a traveling sharp-edge exponentially decaying blast wave, and (2) to compare

the results with those for flat-surface "damper" type motion resulting from the same loading. 28 pp. Illus.

- **RM-1682-AEC (AD 97450).** Calculation of fields on plasma ions by collective coordinates. A. A. Broyles. 4-24-56. Unclassified.

Computations, with the aid of collective coordinates, on the probability of finding a given electric field on an ion in a plasma. All the ions are assumed to have the same charge, and the free electrons are replaced by a rigid negative smear. The Jacobian of the transformation to collective coordinates is expanded in a series of Hermite polynomials, and one of the higher terms is computed as an estimate of the error. 33 pp. Illus.

- **RM-1687 (AD 95542).** Communication networks—I: optimal design and utilization. R. E. Kalaba and M. L. Juncosa. 4-23-56. Unclassified.

Part of a broader investigation on communication networks in an attempt to determine the complex interactions among system capacities, users' demands, and economic factors. The present study, which considers system utilization and design, discusses a general communication system, optimal routing problems as linear programming problems, and optimal design problems in the same framework. 22 pp. Illus. Also published as P-782.

- **RM-1688 (AD 123516).** Communication networks—II: interoffice trunking problems. R. E. Kalaba and M. L. Juncosa. 11-15-56. Unclassified.

An attempt to show how several fundamental interoffice trunking problems for communication networks may be treated by linear programming methods. Various aspects of implementation and generalizations are discussed. It is indicated that as the communications industry turns more to large-scale high-speed computers to cope with its large-scale systems problems, linear programming methods will be increasingly important in carrying out these system-level optimizations. 26 pp. Illus.

- **RM-1692-1 (AD 100024).** A comparison of Soviet and American retail prices in 1950. N. M. Kaplan and E. S. Wainstein. 5-1-56. Rev. 10-3-56. Unclassified.

A summary of previous work on the retail prices of food and manufactured goods, respectively. It is shown that in 1950 the retail purchasing power of the ruble was on the order of 5 or 6 cents, and that the real wage in the Soviet Union was 12 to 16 per cent of the real wage in the United States. 41 pp. Illus. Also published as P-901. See supplement RM-1906.

- **RM-1693 (AD 108748).** Skin temperature variation during re-entry of scientific satellite. D. J. Masson. 3-30-56. Unclassified.

Computations on skin temperature variations during the descent of the scientific satellite from its orbit for 20- and 30-inch-diameter spheres. The skin materials considered are beryllium and aluminum. Since the skin of the satellite will have low heat capacitance, the maximum temperatures of other skin materials are presented. 10 pp. Illus.

- **RM-1704 (AD 112517).** Amplitudes of thermal vibration at fusion. J. J. Gilvarry. 5-1-56. Unclassified.

An attempt to determine relatively accurate values of the Lindemann constant for ten metals by using rigidity moduli at fusion with previously estimated bulk moduli. This study is based on the Debye-Waller theory of the thermal dependence of X-ray reflection intensity. Agreement of the derived value ρ of the critical ratio of root-mean-square amplitude of thermal vibration to nearest-neighbor distance at fusion, with the corresponding value from X-ray intensity data, is improved for the one case (Al) favorable for comparison. 16 pp. Table. Also published as P-854.

- **RM-1707 (AD 260770).** The atomic-hydrogen gun. R. L. Bjork. 5-15-56. Rev. 7-5-61. Unclassified.

An evaluation of the performance of a light-gas gun in which the propellant is energized by an electrical discharge. It is shown that the best performance of such a gun is attained when hydrogen is used as the working fluid and is heated to a point where considerable dissociation occurs, so that the fluid is composed largely of the atomic species. Such a device should lead to higher velocities, for projectiles having well-defined mass and geometry, than have been attainable by other techniques. 55 pp. Illus.

- **RM-1709 (AD 111635). Notes on linear programming—part XXXI: a primal-dual algorithm.** G. B. Dantzig, L. R. Ford, Jr., and D. R. Fulkerson. 5-9-56. Unclassified.

A procedure for solving transportation problems which is a natural extension of the Kuhn-Egerváry method for solving assignment problems. The present paper extends this procedure to the general linear programming case. 16 pp. Tables. Also published as P-778.

- **RM-1710 (AD 101000). Application of dynamic programming to the airplane minimum time-to-climb problem.** T. F. Cartaino and S. E. Dreyfus. 3-22-56. Unclassified.

An application of the dynamic programming technique to the solution of the airplane minimum time-to-climb problem. A typical case is solved. 20 pp. Illus. Also published as P-834.

- **RM-1711 (AD 102059). The Soviet Union and the atom: the early years.** M. J. Ruggles and A. Kramish. 4-2-56. Unclassified.

An attempt to evaluate the early progress of nuclear research in the USSR until the time of Russia's entry into World War II. The study indicates that, beginning in the 1920's and throughout the 1930's, Soviet achievements in atomic research, the caliber of her scientists and their equipment, and the direction of their inquiries were greatly advanced. 107 pp. See also RM-1896, RM-2163, and P-853. Data revised and incorporated in *Atomic Energy in the Soviet Union*, Stanford University Press, Stanford, Calif., 1959. \$4.75.

- **RM-1713 (AD 105407). Hypersonic, nonviscous flow around a circular disk normal to the stream.** Hyman Serbin. 5-3-56. Unclassified.

The first of several studies dealing with the flow field around a blunt body of revolution immersed in a hypersonic, inviscid stream. This research memorandum considers a body which is a disk mounted normal to the free stream. The principal assumption is that the ratio γ of specific heats in the flow behind the shock is near unity. The analysis is limited to first order terms in $\gamma - 1$. 26 pp. Illus. Also published as P-930. See also RM-1772, P-1069, and P-1172.

- **RM-1718 (AD 117482). The optimization of nozzle area ratio for rockets operating in a vacuum.** Martin Goldsmith. 5-24-56. Unclassified.

The development of a systematic method for determining the nozzle area ratio which will provide maximum velocity. Correct area ratio becomes more important as the ratio of nozzle weight to burnout weight increases. 14 pp. Illus. Also published as P-1112.

- RM-1719 (AD 115366). Performance of the "double-threshold" radar receiver in the presence of interference.** Lt. I. W. Linder, Jr., USN, and P. Swerling. 5-28-56. Unclassified.

A study which indicates that the double-threshold radar receiver is effective in suppressing false alarms produced by certain types of interfering electronic signals, with a very small sacrifice in target detection capability. Curves of false alarm rate and signal-to-noise ratio required for target detection are calculated for various values of the relevant parameters and for several target fluctuation models. 77 pp. Illus. See also RM-753, RM-754, RM-1008, and RM-1217.

- RM-1723 (AD 105967). The views of corporation executives on the probable effect of the loss of company headquarters in wartime.** M. B. Rowan and H. V. Kincaid (Bureau of Applied Social Research, Columbia University). 5-1-56. Unclassified.

A discussion of the probable effect of the loss of headquarters offices and top executives of large manufacturing corporations upon the continuation of production in an all-out emergency situation. This study considers the existing plans of these corporations for top-management continuity, the difficulties arising from the loss of headquarters, several factors mitigating such a loss, and some requirements for emergency plans. 97 pp.

- **RM-1724 (AD 109936). Some physical qualifications for reliability formulas.** W. J. Howard. 6-1-56. Unclassified.

An extension of RM-1058, *Chain Reliability: A Simple Failure Model for Complex Mechanisms*, which analyzed the effect of complexity on the reliability of a chain. The present study deter-

mines formulas for reliability as a function of complexity, redundancy, and time for various stress-strength conditions. In addition, the merits of using redundancy at different levels of system subdivision are considered. 26 pp. Illus.

- **RM-1725 (AD 112403). Lunar instrument carrier: landing factors.** H. A. Lang. 6-4-56. Unclassified.

One of a series of research memoranda dealing with a possible rocket to the moon. The present study discusses the problem of landing an instrument package on the moon. The probable nature of the moon's surface is considered as a limiting factor on the velocity of impact, the angle of infall, and the construction of the rocket carrying the instrument package. 45 pp. Illus.

- **RM-1726 (AD 123557). Motion of a small body in earth-moon space.** R. W. Buchheim. 6-4-56. Unclassified.

A presentation of analytical relations and numerical data that may be useful in studies of the trajectories of unpowered vehicles in the region of space dominated by the gravitational fields of the earth and moon. 91 pp. Illus.

- **RM-1728 (AD 260058). Lunar instrument carrier: trajectory studies.** H. A. Lieske. 6-4-56. Rev. 6-25-58. Unclassified.

One of several RAND studies on problems related to landing a package of scientific instruments and associated equipment on the surface of the moon. This research memorandum presents the results of a study of earth-moon "transit" trajectories describing the two-dimensional free-flight motion of a vehicle from a given point above the earth—reached by a matching powered-ascent trajectory—to impact on the surface of the moon. By varying the initial parameters of the flight, the author examines their effect upon the location of the impact point and, for transit trajectories that miss the moon, upon the proper position for placing the vehicle in orbit around the moon. 93 pp. Illus.

- **RM-1730 (AD 112402). Lunar instrument carrier: attitude stabilization.** R. W. Buchheim. 6-4-56. Unclassified.

An estimate of the magnitudes of various attitude disturbances acting on a moon rocket. Such disturbances include initial misalignment, initial pitch and yaw rates, solar radiation torque, and the gravitational gradient of the earth. In addition, vehicle design restrictions are indicated. 25 pp. Illus.

- **RM-1733 (AD 111505). Collective farm investment in the USSR.** N. M. Kaplan. 6-12-56. Unclassified.

One of a series of studies concerned with Soviet capital formation from 1923/24 to date. The present study discusses basic collective farm investment in the USSR, the Agricultural Bank loans and bank-financed investment, and some estimates of collective farm money investment for specific years. 55 pp. Tables.

- **RM-1735 (AD 105408). Surface-protection and cooling systems for high-speed flight.** D. J. Masson and C. Gazley, Jr. 3-23-56. Unclassified.

A discussion of systems for surface protection against transient and continuous heat inputs, corresponding to typical missile and aircraft flight paths. Comparisons of various systems are made for several typical operating conditions. 44 pp. Illus. Also published as P-829.

- **RM-1736 (AD 111816). Notes on linear programming—part XXXII: solving the transportation problem.** L. R. Ford, Jr., and D. R. Fulkerson. 6-20-56. Unclassified.

A description of a new computing procedure for the Hitchcock-Koopmans transportation problem and a step-by-step solution of an illustrative example. The procedure is based on Kuhn's combinatorial algorithm for the assignment problem and a simple labeling process for solving maximal flow problems in networks. 17 pp. Illus. Also published as P-895.

- **RM-1737 (AD 112371). Notes on linear programming—part XXXIII: a theorem on flows in networks.** David Gale. 6-22-56. Unclassified.

A study which obtains a condition for the existence of a flow from the origins to the destinations (connected by a network of edges of specified finite capacity) such that the flows into the destinations attain prescribed values. The existence theorem, which generalizes a well-known combinatorial theorem of P. Hall, is then applied to a particular example. 18 pp.

- RM-1739 (AD 111639). Some observations on the maximization of Stieltjes integrals. J. T. Robacker. 12-30-55. Unclassified.

A procedure for maximizing a Stieltjes integral subject to integral constraints. This method is closely related to the simplex method of linear programming. An example is given to illustrate the technique. 13 pp.

- RM-1741 (AD 144291). On the optimal use of guided missiles—I: allocation of missiles. R. E. Bellman. 7-2-56. Unclassified.

The first of a series of studies concerned with mathematical problems arising in the use of guided missiles. The present study deals with the optimal allocation of missiles against a given target system. It is shown that the computational solution of these problems can be greatly simplified by means of the functional-equation technique of dynamic programming. The method proposed is applicable to a large class of problems involving the allocation of resources, both economic and military. 11 pp. See also R-245 (out of print) and supplement RM-1742.

- RM-1742 (AD 144292). On the optimal use of guided missiles—II: dummy missiles. R. E. Bellman. 7-2-56. Unclassified.

A continuation of RM-1741, which considered the optimal allocation of missiles against a given target system, assuming that dummy missiles are allowable. The present study deals with the same problem, first under the assumption that dummy missiles are to be used, and second under the assumption that the amount of fissile material available is limited. An attempt is made to present a computational technique that can treat, in a routine fashion, target systems with hundreds of targets, some independent and some in target clusters, under realistic assumptions concerning probability of survival of the individual missile and the type of defense employed. 12 pp. See also R-245 (out of print).

- RM-1743 (AD 105409). A table of the Planck radiation function and its integral. F. R. Gilmore. 7-2-56. Unclassified.

A presentation of the values of the dimensionless Planck function, $x^3/(e^x - 1)$, and its normalized integral, $(15/\pi^4) \int_0^x x^3/(e^x - 1) dx$, to five significant figures, for $x = 0$ (0.02) 10. In addition, five-figure values are given for the Planck function and its complementary integral (between x and ∞) for $x = 10$ (0.1) 20. 21 pp. Tables.

- RM-1744 (AD 112373). The distribution of radial error and its statistical application in war gaming. H. P. Edmundson. 7-5-56. Unclassified.

A discussion of a model concerned with the distribution of weapon radial error and an illustration of its statistical application in war gaming. The density function and cumulative distribution function of the radial error are derived and graphed for one, two, and three dimensions. For each of these cases, formulas are given for the expectation, standard deviation, and median of the radial error. 27 pp. Illus. Also published as P-1473.

- RM-1745 (AD 123528). On the computational solution of dynamic-programming processes—I: on a tactical air-warfare model of Mengel. R. E. Bellman and S. E. Dreyfus. 7-5-56. Unclassified.

The first of a series of studies concerned with the computational solution of dynamic programming processes. The functional-equation approach is used to treat a tactical air-warfare model that A. Mengel previously considered by means of classical variational techniques. 21 pp. Illus. Also published as P-1072.

- RM-1746 (AD 112404). On the computational solution of dynamic-programming processes—II: on a cargo-loading problem. R. E. Bellman and S. E. Dreyfus. 11-5-56. Unclassified.

A presentation of the numerical solution of a cargo-loading problem in which the difficulty arises from indivisibility requirements. A dynamic programming formulation is used. 9 pp. Illus.

- **RM-1747 (AD 123535). On the computational solution of dynamic-programming processes—III: on the optimal use of guided missiles against a fixed target system—maximum expected damage.** R. E. Bellman and S. E. Dreyfus. 1-11-57. Unclassified.

An application of dynamic-programming techniques to the problem of determining the use of guided missiles against a fixed target system. The criterion of maximum expected damage is used, and the case of 100 missiles and 20 targets of varying values is given as an example. 13 pp. Illus.

- **RM-1748 (AD 123558). On the computational solution of dynamic-programming processes—IV: on the optimal use of guided missiles against a fixed target system—maximum probability of success.** R. E. Bellman and S. E. Dreyfus. 4-1-57. Unclassified.

An application of dynamic-programming techniques to the problem of determining the use of guided missiles against a fixed target system. It is assumed that the purpose is to maximize the probability of achieving a damage greater than or equal to a given fixed level. 13 pp. Illus.

- **RM-1749 (AD 144289). On the computational solution of dynamic-programming processes—V: a smoothing problem.** R. E. Bellman and S. E. Dreyfus. 4-2-57. Unclassified.

A study of a particular case of the general problem of balancing cost of undersupply against cost of oversupply. The problem is typical of those arising in production smoothing. A computational solution is given. 15 pp. Illus.

- **RM-1750 (AD 123553). Computational solutions of dynamic-programming processes—VI: on the optimal-trajectory problem.** R. E. Bellman and S. E. Dreyfus. 4-16-57. Unclassified.

An application of dynamic programming theory to the solution of trajectory problems for interceptors. After a discussion of the principles involved, a specific problem is solved. 12 pp. Illus.

- **RM-1751 (AD 156029). On the computational solution of dynamic-programming processes—VII: radar nets.** R. E. Bellman and S. E. Dreyfus. 4-3-58. Unclassified.

A problem concerned with constructing a radar warning line surrounding a set of air bases, such that the length of the perimeter of the configuration is minimum for a given protection level. 16 pp. Illus.

- **RM-1752 (AD 144277). On the computational solution of dynamic-programming processes—VIII: a bottleneck situation involving interdependent industries.** R. E. Bellman and S. E. Dreyfus. 4-17-57. Unclassified.

An examination of the computational solution of a maximization problem arising in the study of the use of interdependent industries. Assuming proportional costs and returns, it is shown that the dimensionality of the problem can always be reduced by one, and that all the transformations occurring can be taken to be "shrinking transformations." These transformations improve greatly the efficiency of the method. 15 pp. Illus. Also published as P-1282.

- **RM-1754 (AD 108746). A revised data-processing system for managing war reserve stocks of aircraft spare parts.** H. W. Nelson and J. D. Tupac. 7-13-56. Unclassified.

A description of a new data-processing system, developed jointly by the Air Force and RAND, for management of war reserve stocks of aircraft spare parts. Initiated because the Air Force was experiencing difficulty with its manual and punched card system, this new system offers substantial advantages. 48 pp. Illus.

- **RM-1755 (AD 109935). Games with payoff discontinuities at discrete points.** O. A. Gross. 6-1-56. Unclassified.

A presentation of an indeterminate game G on the unit square S . It is assumed that G has a bounded rational continuous payoff at all except three points of S and that, of the three discontinuities, only one is nonremovable. 8 pp.

- **RM-1756 (AD 104678) (out of print). Recent trends in Soviet labor policy.** J. G. Glikzman. 7-2-56. Unclassified.

A continuation of P-754, *Postwar Trends in Soviet Labor Policy*. The present study discusses USSR labor legislation following its Twentieth Party Congress in an attempt to analyze the recent developments in labor law which culminated in the decree of April 1956. 41 pp. Superseded by RM-2494.

- **RM-1757 (AD 108749). A linear programming model of the U.S. petroleum refining industry.** A. S. Manne. 7-17-56. Unclassified.

An attempt to estimate for the petroleum refining industry (1) the maximum amount attainable of a certain product-mix, exclusive of jet fuel, and (2) the effect of increased production of this fuel on the output rate. It is assumed that refining equipment and raw materials available in the United States on January 1, 1953, are used. 54 pp. Illus. Also published as P-563.

- **RM-1759 (AD 112135). A new approach to the military budget.** David Novick. 6-12-56. Unclassified.

A proposed budget procedure to aid planners in obtaining the best military capability in support of over-all objectives. Stated in terms of specific understandable objectives appropriate to the level of decision concerned, this budget provides (1) summaries which identify end-product units of military capability and accumulate all service-wide costs of these units and (2) detailed support documents which identify each element of activity and the administrative responsibility of specific actions. 35 pp. Tables.

- **RM-1760 (AD 108750). A casebook on Soviet astronautics.** F. J. Krieger. 6-21-56. Unclassified.

A survey of published Soviet materials on astronautics. Part I deals with a four-part bibliography on the historical, scientific, and technical aspects of rocketry and astronautics. Part II contains translations from the Russian of articles and papers by various authorities. 252 pp. Illus. Superseded by R-311 (out of print).

- **RM-1762 (AD 110881). Estimating ground motions resulting from air-induced ground shocks.** J. H. Huth. 7-23-56. Unclassified.

A discussion of P-884, *Elastic Stresses Produced in a Half-plane by Steady Moving Loads*, as the results apply to estimating ground motions from air-induced ground shocks. Dimensionless graphs show ground velocities and accelerations from constant-velocity, two-dimensional, step, and air-blast loadings, as well as ground accelerations from a constant-velocity, delta loading. 41 pp. Illus.

- **RM-1764 (AD 133007). Observations of the moon from the moon's surface.** W. W. Kellogg. 7-27-56. Unclassified.

An attempt to examine various observations which could be made from the moon by an unmanned instrument carrier system capable of landing a payload on the moon and of telemetering information back to the earth. Some of the observations discussed are measurements of the lunar atmosphere and magnetic field, and seismic exploration. In addition, the creation of a visible flash on the moon with an atomic explosion is discussed. 35 pp. Illus. See also RM-1933 and RM-2106.

- RM-1770 (AD 112385). On the detection of stochastic signals in additive normal noise: part I.** David Middleton. 8-6-56. Unclassified.

An examination of optimum and suboptimum detection of normal signals in additive normal noise backgrounds. General results for optimum receiver structure, error probabilities, and average risk are obtained for colored noise backgrounds. Threshold reception in white noise backgrounds is investigated. In addition, optimum detector structure for signal processes with rational intensity spectra is determined for the white noise case. 130 pp. Illus. Also published as P-1050.

- **RM-1772 (AD 111506). Hypersonic, nonviscous flow around a sphere.** Hyman Serbin. 8-13-56. Unclassified.

A discussion of a theory of hypersonic flow for the flow field around a sphere. This theory is used to predict the shock shape and shock location in the subsonic part of the flow field. Comparison with experimental data is satisfactory. 15 pp. Illus. See also RM-1713, P-930, P-1069, and P-1172.

- **RM-1778-RC. Economic development and mutual security: some problems of U.S. foreign assistance programs in Southeast Asia.** Charles Wolf, Jr. 8-14-56. Unclassified.

Part I of an investigation concerned with U.S. foreign assistance programs in Southeast Asia. The present study examines an experimental model of the relationship between political vulnerability and (1) economic aspirations, (2) the level of living, and (3) economic expectations. In addition, applications of this model are shown. 77 pp. Tables.

- **RM-1779-AEC. Stark effects in line broadening.** Henry Margenau. 5-23-56. Unclassified.

A study which shows, for a system comprised of an atom and a perturbing electron, that treatment of the electron as a quantum mechanical wave packet leads to the classical impact theory of ion Stark broadening. 15 pp.

- RM-1785 (AD 109940). Costs and benefits in mathematical programming.** A. S. Manne. 8-27-56. Unclassified.

An application of linear programming methods to month-to-month airlift planning within the U.S. Military Air Transport Service. Linear programming methods are substituted for trial-and-error calculations in an attempt (1) to diminish the time required to adapt plans to radical changes in the airlift problem and (2) to increase the productivity of MATS' resources. 18 pp. Illus. Also published as P-936.

- RM-1786 (AD 112413). Relationships between weapons and logistics expenditures.** M. A. Geisler. 8-28-56. Unclassified.

A discussion of the trade-offs which are made between investing in a weapon and in its logistics support. This study examines (1) some logistic implications of the present need to maintain a high level of operational readiness of the Air Force, (2) the nature of the relationships among weapons, supply support, and maintenance support, and (3) the problem of allocation. 28 pp. Illus. Also published as P-1036.

- **RM-1793-AEC. Thermodynamic properties of mixtures on the statistical model.** J. J. Gilvarry and W. G. McMillan. 8-28-56. Unclassified.

A method of deriving Brachman's results for the thermodynamic functions of the Thomas-Fermi atom. This method is presented in a generalized form applicable to mixtures of electrons and light nuclei in the field of a heavy nucleus. 6 pp.

- **RM-1794 (AD 133002). Transport coefficients of dissociating and slightly ionizing air.** P. H. Greifinger. 4-9-57. Unclassified.

Estimates of the transport coefficients of a dissociating diatomic gas and an ionizing monatomic gas for degrees of ionization up to about 10 per cent. The results are generalized for a mixture of diatomic gases of similar molecular weights, such as air. Numerical values of the viscosity, thermal conductivity, and Prandtl number for air are shown graphically. 28 pp. Illus.

- **RM-1796 (AD 117481). On the optimization of two-stage rockets.** Martin Goldsmith. 9-21-56. Unclassified.

An attempt to determine the optimum distribution of weight for a two-stage tandem rocket for the case of different structural factors and propellant specific impulses in each stage. The criterion of optimization used is the minimization of gross weight for a given required burnout velocity and payload. 9 pp. Also published as P-1004.

- **RM-1798 (AD 112372). Notes on linear programming—part XXXIV: a primal-dual algorithm for the capacitated Hitchcock problem.** L. R. Ford, Jr., and D. R. Fulkerson. 9-25-56. Unclassified.

An algorithm for solving capacitated Hitchcock problems and a proof of convergence in a finite number of steps. The proposed algorithm is a generalization of a combinatorial method discovered by Kuhn for the optimal assignment problem. It uses as a subroutine the flow algorithm previously developed. 17 pp. Illus. Also published as P-827.

- **RM-1799 (AD 112392). Notes on linear programming—part XXXVII: concerning multicommodity networks.** J. T. Robacker. 9-26-56. Unclassified.

A generalization of the minimum-cut, maximum-flow theorem to multicommodity networks. The generalization is expressed as a decomposition theorem that is established for these networks. 13 pp. Illus.

- **RM-1801. A linear programming model of the gaseous diffusion isotope-separation process.** D. M. Fort. 10-1-56. Unclassified.

An attempt to indicate how the gaseous diffusion process, as applied to the separation of uranium isotopes, may be analyzed in terms of a linear programming model. It is shown that by a suitable choice of variables a linear programming model of the separation cascade may be set up that incorporates these boundary conditions as well as the material balance and separation capacity constraints. The model may be incorporated in larger models involving other elements such as nuclear reactor and chemical processing facilities. 76 pp. Illus.

- **RM-1802-AEC (AD 112386). The correlation energy of an electron gas at high density.** M. Gell-Mann and K. A. Brueckner. 10-3-56. Unclassified.

A discussion of the idealized problem of the ground state energy of a gas of electrons in the presence of a uniform background of positive charge that makes the system neutral. The quantity ϵ_c is defined as the correlation energy per particle of an electron gas expressed in Rydbergs. It is a function of the conventional dimensionless parameter r_s , where r_s^{-3} is proportional to the electron density. The method of computation is based on summing the most highly divergent terms of the perturbation series under the integral sign to give a convergent result. 18 pp. Illus. See also RM-1823-AEC.

- **RM-1803 (AD 123520). Base-Depot Model studies.** H. W. Karr. 1-1-57. Unclassified.

A collection of logistics systems studies which attempt to show how the Base-Depot Model may be used to aid in policy-making. This model is a set of arithmetic and logical procedures which can be performed by an electronic computer to simulate the behavior of a segment of the Air Force supply system. The model is applied to present and alternative base and depot stocking policies to the effect of the length of demand history on supply performance, and to alternative routine transportation and data-processing systems. 231 pp. Illus.

- **RM-1806 (AD 112379). Report on the dynamic strength of rigid-plastic beams under blast loads.** M. G. Salvadori and P. Weidlinger. 10-8-56. Unclassified.

An analysis to determine upper bounds to the dynamic strength of simply supported beams acted upon by a uniformly distributed blast pressure. Rigid-plastic behavior in bending and/or in shear (development of "plastic hinges" and/or "plastic slides") is assumed. The time variation of the blast pressure is approximated by a negative exponential time function with peak value at $t = 0$. 43 pp. Illus.

- **RM-1807 (AD 112378). A method for estimating engine failure rates.** T. E. Harris. 10-9-56. Unclassified.

An application of a standard statistical method to the problem of estimating engine failure rates from observations on a group of engines. The method is applicable when it can be assumed that the probability of failure by an engine of age t flying one additional hour is $\exp(a + bt)$, where a and b are unknown parameters to be estimated. 26 pp. Illus.

- **RM-1809 (AD 123549). Vulnerability and recuperation of a regional economy: a study of the impact of a hypothetical atomic attack on New England.** P. G. Clark. 10-12-56. Unclassified.

An attempt to determine the economic consequences of bombing attacks on a region of the nation. Both heavy and light bombing attacks on New England are postulated, with and without warning. An assessment is made of the surviving economic capacity and the probable demands upon that capacity. The purpose of the study is primarily to explore a method of analysis, not to make an explicit forecast. 99 pp. Tables.

- **RM-1814 (AD 112377). Note on neutron flux-current boundary conditions at gaps in one-dimensional systems.** G. M. Safonov. 10-25-56. Unclassified.

A method for connecting the neutron flux and current across gaps in one-dimensional systems (i.e., systems with spherical, cylindrical, and laminar symmetries). For a gap in a laminar system, the rigorous boundary condition is the continuity of the Boltzmann flux as the gap is crossed. With the spherical and cylindrical systems, the curvature of the gap boundaries must enter into a suitable condition relating neutron densities on the two sides of a void. 5 pp.

- RM-1817 (AD 112414). Air Force logistics: some recent developments.** A. R. Ferguson. 11-5-56. Unclassified.

A study of the developments in Air Force logistics designed to make the system capable of performing its functions in the military environment in the early 1960's. Such aspects are discussed as the introduction of improved logistics policies, the role of airlift, and maintaining control over Air Force assets. 31 pp. Illus. A revision of P-855.

- **RM-1818 (AD 112395). Equilibrium points in games with vector payoffs.** L. S. Shapley. 11-15-56. Unclassified.

An attempt to define and characterize the equilibrium-point solutions of games of a certain kind. It is assumed that the payoff of the game considered sometimes takes the form of a vector having components that represent amounts of different things which have unknown relative values. 9 pp. Also published as P-1212.

- **RM-1819 (AD 112390). Soviet collective leadership.** E. Bernaut and M. J. Ruggles. 10-1-56. Unclassified.

An analysis of the present leadership in the Soviet Union and a description of the differences in structure, mechanisms, and policy trends of the Stalin and post-Stalin governments. This study is intended to provide a guide for assessing the future stability of the Soviet government. 165 pp.

- **RM-1820 (AD 112415). The goodness-of-fit statistics of Kolmogorov and Smirnov.** H. P. Edmundson. 9-30-56. Unclassified.

An examination of the goodness-of-fit statistics of A. Kolmogorov and N. Smirnov. The theory and applications of these statistics are summarized and compared with the classical χ^2 statistic for testing goodness of fit. 27 pp. Illus. Also published as P-1474. See also RM-1905 and RM-1958.

- **RM-1821 (AD 123534). Electric power development in mainland China: prewar and postwar.** K. C. Yeh. 11-27-56. Unclassified.

A study which outlines the major trends in the growth of the electric power industry in Mainland China and examines some of the problems in the course of its development. The period covered is 1932 to 1955, with emphasis given to the years 1932 to 1936 and 1949 to 1955. 125 pp. Illus.

- Ø ● **RM-1823-AEC (AD 112391). The specific heat of a degenerate electron gas at high density.** Murray Gell-Mann. 11-11-56. Unclassified.

A generalization of RM-1802-AEC, *The Correlation Energy of an Electron Gas at High Density*, in that not only the ground state but also the low excited states of an electron gas are discussed. The specific heat of the gas at low temperature is proportional to the density of single particle levels at the surface of the Fermi sea, or inversely proportional to $(dW/dp)p = 1$. This last quantity is calculated for high density (small r_s , where density is proportional to r_s^{-3}) and compared to the corresponding quantity for a free electron gas. 12 pp. See also P-988-AEC.

- Ø • **RM-1824-AEC (AD 133030). Point source explosion in air.** H. L. Brode. 12-3-56. Unclassified.

A solution to the problem of the blast wave from a point source in air. The methods and the equation of state for air are described, together with the results of the particular solution for a point source (giving shock values of pressure, density, particle velocity, temperature, and dynamic pressure as functions of the shock radius and of the peak overpressure). The time histories of the same variables are presented for a number of distances from the source, as well as values of the durations of positive phases and impulses from overpressure and from dynamic pressure. 87 pp. Illus. See also RM-1913-AEC.

- Ø • **RM-1825-AEC. The blast wave in air resulting from a high-temperature, high-pressure sphere of air.** H. L. Brode. 12-3-56. Unclassified.

The results of a calculation of the blast wave resulting from the explosion of a sphere of air initially at rest and at standard sea-level density but at 20,000 atmospheres pressure. These results are presented in graphical form, showing the variations of overpressure, density, particle velocity, temperature and dynamic pressure as functions of space and time. Shock values of these parameters, total impulses, positive durations, and shock arrival times are illustrated. Comparison is made with other calculations and with observations. 69 pp. Illus.

- **RM-1829 (AD 123512). Techniques of systems analysis.** H. Kahn and I. Mann. 12-3-56. Unclassified.

A section of a proposed book on military planning in an uncertain world. The present study (Part I) discusses such aspects of the techniques of systems analysis as designing the offense and defense, probabilistic considerations, and the two-sided war. Other parts of the book will deal with the techniques of operations research and philosophical and methodological comments. The material has been gathered from a series of lectures given for the RAND Systems Analysis course. 175 pp. Illus. See companion piece RM-1880. See also RM-1937.

- RM-1830 (AD 123536). Air Force provisioning policies: an analysis.** W. A. Steger. 4-10-57. Unclassified.

A review of present Air Force policies for initial provisioning of spare parts. The present system is described, together with the reasons leading to its development. It is shown that (1) spares delivered during the first few years of a weapon considerably exceed expected demands, (2) expected demand is generally overestimated as a precaution, and (3) under current policy and uncertainty a large percentage of initial provisioning purchases represent life-of-type procurement, which is more costly than necessary for adequate protection against stock-outs of spare parts. 40 pp. Illus.

- **RM-1832 (AD 112411). Notes on linear programming—part XXXV: discrete-variable extremum problems.** G. B. Dantzig. 12-6-56. Unclassified.

A review of some recent successes in the use of linear programming methods for solving discrete-variable extremum problems. One example of the use of the multistage approach of dynamic programming is also discussed. 27 pp. Illus. Also published as P-876. Presented before the Operations Research Society of America at Los Angeles, California, August 16, 1955.

- **RM-1833 (AD 112418). Notes on linear programming—part XXXVI: the allocation of aircraft to routes—an example of linear programming under uncertain demand.** A. R. Ferguson and G. B. Dantzig. 12-7-56. Unclassified.

An application of linear programming to the problem of allocating aircraft to routes to maximize expected profits when there is uncertain demand. It is assumed that (1) the demand for each activity over the pertinent time period, while not known, can be estimated as a distribution of values and (2) each of these values has a specified probability of being the actual value. 46 pp. Tables. Also published as P-727.

- **RM-1835 (AD 112410). The criticality and some potentialities of "cavity reactors" (abridged).** G. M. Safonov. 7-17-55. Unclassified.

An attempt to determine a critical equation for reacting systems with cores of very low density, thermally fissionable material surrounded by a moderating reflector. The critical mass of cavity

reactors which employ U^{235} , U^{233} , and Pu^{239} for fuel and D_2O , Be, and C for reflector is given as a function of core size. In addition, possible implications of cavity reactors are discussed. 22 pp. Illus. An abridged version of RM-1520. See supplement P-986.

- **RM-1837 (AD 112399). Soviet atomic blackmail and the North Atlantic Alliance.** Hans Speier. 12-10-56. Unclassified.

Part of a broader investigation concerned with the politics of German rearmament. The present memorandum discusses atomic blackmail as it applies to West Germany. While the Soviets can exploit the threat-value of their atomic weapons against European members of NATO, a new balance of atomic power will be achieved when individual NATO members acquire their own effective atomic capability. The furtherance of Soviet policy by this type of threat is shown in connection with the recent Middle East crisis. 43 pp. Also published as P-1094.

- **RM-1842 (AD 112401). Implications of nuclear weapons in total war.** Bernard Brodie. 12-17-56. Unclassified.

Part of a broader investigation concerned with the general theory of air strategy in a nuclear age. The present memorandum states that (1) an unrestricted strategic air campaign in a war in which the United States is engaged will be decisive, (2) strategic bombing will prove other kinds of military operations unfeasible, and (3) those surviving strategic attack will be far more important in the national recovery following hostilities rather than in controlling the subsequent course of the war. 34 pp. Also published as P-1118. Incorporated in R-335. Also incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, N.J., 1959. \$6.50.

- **RM-1844 (AD 112406). A recoverable scientific satellite.** C. Gazley, Jr., and D. J. Masson. 12-21-56. Unclassified.

A study of the problems of satellite re-entry, with emphasis on the requirements for a recoverable satellite. Location of the impact point (rather than re-entry heating) seems the most difficult aspect of a recovery program but can be accomplished by radio tracking and ultimate recovery by means of a radio beacon. 34 pp. Illus. See revised version P-958.

- **RM-1845 (AD 123522). Leaders of Communist China.** H. C. Hinton. 12-20-56. Unclassified.

An analysis of the significant data available on the elite which have governed the mainland of China and dominated its public life since 1949. Part I attempts to explain the nature and exercise of power, and the role of leadership, in Communist China. Part II shows what kind of people these individuals are, and the types of careers they have had. 314 pp. Tables.

- Ø ● **RM-1847-AEC (AD 123511). Thomas-Fermi equation of state for dilute gases.** Richard Latter. 1-3-57. Unclassified.

A study which uses the Thomas-Fermi model to determine the electronic component of the equation of state of very dilute gases. 21 pp. Illus.

- RM-1852 (AD 133031). An application of superconductivity to inertial navigation.** W. H. Culver and M. H. Davis. 1-7-57. Unclassified.

A proposal for a new type of gyro which may be suitable for use in inertial guidance systems. The basic element of the system is a spinning, superconducting sphere, maintained at a temperature of a few degrees Kelvin, which is supported by magnetic fields. Such a device may not be susceptible to the drift problems of conventional gyros. 29 pp. Illus. Also published as R-363. See also RM-2592.

- Ø **RM-1853 (AD 112417). Cargo density and airlift.** R. E. Bickner. 1-14-57. Unclassified.

A presentation of (1) the results of RAND studies concerned with variations in the density of air cargo and (2) the effects of these variations on aircraft design, aircraft capacity estimates, airlift operations, and airlift costs. It is shown that air cargo varies in density and is seldom equal to the average generally computed. 71 pp. Illus. See also RM-1380 and P-724.

- **RM-1858 (AD 123514).** Relationships between program elements and system demand for airframe spare parts. T. A. Goldman. 1-22-57. Unclassified.

The results of research on system-wide demand for spare parts by military aircraft. The relation of such demand to program elements is analyzed, and techniques are developed for forecasting future demands on the basis of past data. A new approach used in this study considers the relationships of substitution and interchangeability among parts, of part applicability within the weapons system, and of the differences between base-level and system-level demand for spare parts. In particular, the Worldwide Stock Balance and Consumption Reports are examined for B-47 airframe parts (primarily in Category I). 88 pp. Illus.

- **RM-1859 (AD 123533).** Notes on linear programming—part XXXIX: slightly intertwined linear programming matrices. R. E. Bellman. 1-23-57. Unclassified.

The use of the functional equation approach of dynamic programming to treat a linear programming problem. This problem involves a slightly intertwined matrix, i.e., one which is almost block diagonal. 10 pp. See condensed version P-918.

- RM-1860 (AD 123530).** Solution of a ranking problem from binary comparisons. L. R. Ford, Jr. 6-7-56. Unclassified.

A method for solving a ranking problem from binary comparisons which does not require any specific number of comparisons between pairs. This procedure may be applied to such problems as ranking (1) various makes of automobiles and (2) players of a two-person game on the basis of their records against each other. 14 pp. Also published as P-877.

- **RM-1861 (AD 123515).** An industrial-location planning problem. O. A. Gross and S. M. Johnson. 1-28-57. Unclassified.

A discussion of certain special cases of a construction-planning problem involving water pollution. The general problem, which has both combinatorial and permutational aspects, is shown to be reducible to a purely combinatorial problem by means of a theorem that eliminates the permutational aspect. 10 pp.

- RM-1863-1.** An analysis of the rotational motion of a body during re-entry. T. B. Garber. 1-28-57. Rev. 6-28-61. Unclassified.

An analysis of the oscillatory motion of a re-entry vehicle which is spinning about its longitudinal axis. The influence of the spin rate and the static margin upon the stability of the transient solution of the equations of motion is considered. The precessional and nutational motion of the vehicle is examined, and the effect of initial conditions upon these modes of oscillation is indicated. In addition, the planar re-entry case is analyzed, and the results are compared with those obtained by previous investigators. 67 pp. Illus.

- **RM-1864 (AD 123513).** Notes on linear programming—part XXXVIII: note on B. Klein's "Direct use of extremal principles in solving certain problems involving inequalities." G. B. Dantzig. 1-29-57. Unclassified.

A discussion of B. Klein's proposal that ordinary methods of the differential calculus be used to minimize a function z of n variables x_1, x_2, \dots, x_n , where the latter are subject to inequality constraints instead of the usual equality constraints. The present study considers whether this method may be constructively used for determining the optimum. 11 pp. Also published as P-763.

- **RM-1865-AEC (AD 112420).** The characteristic energy loss of electrons passing through metal foils: II. Dispersion relation and short wave length cutoff for plasma oscillations. R. A. Ferrell. 12-28-56. Unclassified.

An attempt to determine the shortest wave length at which plasma oscillations can be sustained by a degenerate electron gas. A method is used to provide a direct quantum mechanical analog to the Bohm-Gross derivation of the dispersion relation. The effect of electron exchange decreases somewhat the dependence of the plasma frequency on wave number. The maximum wave number corresponds sufficiently to the momentum to cause an electron at the surface of the Fermi sea to make a real transition, absorbing one plasma quantum of energy. 32 pp. Illus. See also P-1002-AEC.

- RM-1866 (AD 123529). **Strategic air power in World War II.** Bernard Brodie. 2-4-57. Unclassified.

Part of a broader investigation concerned with the general theory of air strategy in a nuclear age. Based on literature published by the U.S. Strategic Bombing Survey, the present study considers the Allied strategic bombing campaigns against Germany and Japan in World War II. The author concludes that these strategic successes were questionable in that they either came too late to have a decisive effect or they were imposed on an enemy already prostrated by other forms of war. 46 pp. Incorporated in R-335. Published in *Strategy in the Missile Age*, Princeton University Press, Princeton, N.J., 1959. \$6.50.

- RM-1867 (AD 123519). **Design change impacts on airframe parts inventories.** J. W. Petersen and W. A. Steger. 2-7-57. Unclassified.

An examination of the impacts of design changes upon Air Force inventories of delivered airframe spare parts. The impacts discussed include engineering obsolescence costs, modification costs, contractor design-termination costs, and the costs of parts the applicability of which is limited by a design change. The measures of obsolescence developed are based primarily on the experience of the F-94 series of aircraft. 37 pp. Illus. See revised version P-1055.

- RM-1868 (AD 123538). **Fibered materials for flight structures.** G. A. Hoffman. 2-18-57. Unclassified.

An evaluation of the possible future role of high-strength fibers ("whiskers") in tension structural elements. The known properties of fibers are reviewed, and some possible production techniques are discussed. Fibered materials for use at various temperatures are chosen according to a derived criterion. Hypothetical structural elements fabricated from fibered materials are compared on the basis of weight with conventional-material elements. Weight reductions by a factor of 5 appear possible through this structural technique. An estimate is made of the worth-in-use of fibered materials, and suggestions for research are offered. 68 pp. Illus.

- RM-1870. **Direct conversion of fission to electric energy in low-temperature reactors.** George Safonov. 1-8-57. Unclassified.

A review of the idea of producing electricity directly from electrically charged fission fragments in light of the new cavity reactor concept. Refueling possibilities including a continuous scheme are noted. Failure of vacuum insulation under irradiation conditions is recognized as a possible major development problem. Logical and inexpensive first experiments in fission-electric cell development are suggested, and possible applications of fission-electric reactors in the research accelerator, central station power, and other fields are discussed. 68 pp. Illus.

- RM-1872 (AD 133014). **A materials-input index of Soviet construction, 1927/28 to 1955—part I.** R. P. Powell. 2-14-57. Unclassified.

An attempt to estimate changes in the physical volume of construction in the USSR from 1928 to 1955. An index of the volume of materials employed in construction, weighted by 1937 prices, is compiled as an estimate of the index of the physical volume of construction. Alternative methods of measuring the volume of construction are discussed, and the results of alternative methods in the Soviet case are compared. 88 pp. Illus. See Part II, RM-1873. See revision RM-2454.

- RM-1873 (AD 133015). **A materials-input index of Soviet construction, 1927/28 to 1955—part II: appendices.** R. P. Powell. 2-14-57. Unclassified.

A continuation of RM-1872, Part I of this investigation. The present study gives the detailed data, sources, and methods underlying the index of the physical volume of construction described in Part I. 559 pp. Tables. See revision RM-2454.

- RM-1874 (AD 123521). **The politics of Soviet de-Stalinization.** R. C. Tucker. 2-14-57. Unclassified.

A discussion of the Soviet political system as a command and control structure and of a concept of Stalinism as a political form. Against this background, the author investigates the meaning, motives, and limits associated with de-Stalinization. It is indicated that the future of internal Soviet politics may revolve in some measure around the clash between the official and unofficial concepts of this issue. 56 pp. Also published as P-1058.

- **RM-1875 (AD 123552). Odessa, 1941–1944: a case study of Soviet territory under foreign rule.** Alexander Dallin. 2-14-57. Unclassified.

An historical reconstruction of events in Transnistria during World War II at the time of its siege and occupation by Rumania to determine the lessons that can be drawn from this experience. A comparison of Rumanian rule with German occupation in other parts of the USSR during the same years discloses many problems of occupation and the occurrences accompanying the removal of Soviet controls. 488 pp.

- **RM-1877 (AD 150660). Optimal employment of tactical air forces in theater air tasks: a game-theoretic analysis.** L. D. Berkovitz and M. Dresher. 2-21-57. Unclassified.

A description, in terms of a two-sided war game, of the optimal allocation of tactical aircraft among three air tasks—counter air, air defense, and support of ground operations—on each strike of a multistrike campaign. The mathematical model assumes that counter-air missions destroy enemy aircraft, air-defense missions reduce the enemy's counter-air operations, and support of ground operations contributes to the accomplishment of the theater mission, or payoff, of the tactical forces. 23 pp. Table.

- **RM-1880 (AD 123517). Graphs of partial sums of the binomial distribution.** H. Kahn and I. Mann. 2-27-57. Unclassified.

Graphs used in calculations for RM-1829-1, *Techniques of Systems Analysis*. The values are taken from the tabulations of

$$R = \sum_{i=r}^n \binom{n}{i} p^i (1-p)^{n-i}.$$

14 pp. Illus. See also RM-1937.

- **RM-1881 (AD 123523). The psychological factor in Soviet foreign policy.** R. C. Tucker. 3-7-57. Unclassified.

A study of the implications of Stalin's death for changing the motivation of Soviet foreign policy. During the Stalinist era foreign territory and people participating in the cult of the USSR were totally controlled, the world was divided between two antagonistic camps, and the notion of political neutrality was excluded in world politics. In the post-Stalin period a new expansionism of Soviet influence arose to create new spheres of influence, and the competition for preponderance in third states caused the two-world image to disappear. 33 pp. Also published as P-1052. See also RM-1949.

- **RM-1882 (AD 123542). Deterrence.** Olaf Helmer. 3-11-57. Unclassified.

A discourse on the issues involved in deterrence. Such topics are considered as retaliatory capability and intentions, war plan assumptions, peripheral deterrence, and deterrence strategy. 8 pp. Also published as P-1144.

- **RM-1883 (AD 123541). Khrushchev and the Stalin succession: a study of political communication in the USSR.** Myron Rush. 3-20-57. Unclassified.

An examination of the communications of Soviet leaders and authoritative writers on matters affecting the distribution of power and authority among the Soviet elite since Stalin's death. This study supports the contention that since Stalin's death political power in the USSR has been appreciably diffused outside the circle of the top leadership. 257 pp. Tables. See also RM-1947, P-1135, and P-1146. Incorporated in *The Rise of Khrushchev*, Public Affairs Press, Washington, D.C., 1958. \$3.25.

- **RM-1888 (AD 123554). On the formulation of dynamic-programming problems—I.** R. E. Bellman and S. E. Dreyfus. 4-4-57. Unclassified.

A presentation of a wide variety of complicated multidimensional computational problems that can be treated by dynamic programming theory. Part I considers a logistics problem which involves the purchasing and servicing of numerous items. Part II shows how target-selection problems arising in the attack on a target complex by weapons of several different types or by successive waves of weapons of the same type may be treated. Part III discusses the solution of the optimal-inventory problem with delivery lags of arbitrary length. 15 pp.

- **RM-1889 (AD 123555).** On the computational solution of dynamic-programming processes—X: the flyaway-kit problem. R. E. Bellman and S. E. Dreyfus. 4-5-57. Unclassified.

A study of the flyaway-kit problem, a special case of the cargo-loading problem. A kit that minimizes the expected cost due to shortage of a spare part is computed subject to restrictions on the weight and size of the kit. 12 pp. Illus.

- RM-1890 (AD 123537).** A briefing on a method of estimating spare part essentiality. H. W. Karr. 4-5-57. Unclassified.

A presentation of a set of essentiality categories with examples which seem applicable to all tactical fighter-bombers. The author discusses (1) the ways in which essentiality factors can be used, (2) various elements to be considered in estimating essentiality factors, (3) an experiment with psychometric scaling techniques, and (4) a rationale for assigning essentiality or shortage penalty factors to particular categories of items. 42 pp. Illus. Also published as P-1064.

- **RM-1892 (AD 133025).** Linearized solution for heat addition at the surface of a supersonic airfoil. Carl Gazley, Jr. 11-21-56. Unclassified.

A presentation of a simple linearized solution for the aerodynamic characteristics of a supersonic airfoil with surface heat addition. These characteristics are applicable to slender airfoils at moderate supersonic Mach numbers and moderate rates of heat addition. Heat addition on the lower surface of the airfoil results in increased lift and/or decreased drag. 34 pp. Illus.

- **RM-1893 (AD 123545).** The growth of China's scientific and technical manpower. F. C. Iklé. 4-24-57. Unclassified.

A study concerned primarily with the future capability of Communist China's educational system and with the expansion of its scientifically trained manpower. It is concluded that the Chinese Communists should not find it difficult to provide the technical manpower for the capital equipment they have accumulated, although there may be shortages in certain specialized skills or in geographical regions. 75 pp. Illus. Also published as P-1104.

- **RM-1895 (AD 133011).** Minimum-weight design of sandwich panels. L. E. Kaechele. 3-22-57. Unclassified.

A method for determining the optimum configuration of flat, simply supported sandwich panels under uniaxial compression. It is assumed that the load, width, and stress-strain curves for the face material are given, with side conditions on the maximum allowable face stress (or strain) and on core strength or density. Application to square- and hexagonal-cell honeycomb core panels is shown, and elevated temperature effects are discussed. 59 pp. Illus. See also R-222 (out of print).

- **RM-1896 (AD 123543).** The Soviet Union and the atom: the "secret" phase. Arnold Kramish. 4-11-57. Unclassified.

A continuation of RM-1711, *The Soviet Union and the Atom: The Early Years*. The present study discusses the virtual abandonment of Soviet atomic research during World War II and the renewal of this research in 1943. Although the project was maintained on a relatively small scale, their first chain-reacting device was achieved in 1947. With the test of their first atomic bomb more than two years away, however, the Soviets felt in 1947 that they could proceed confidently with the program. 89 pp. See also RM-2163 and P-853. Data revised and incorporated in *Atomic Energy in the Soviet Union*, Stanford University Press, Stanford, Calif., 1959. \$4.75.

- RM-1898 (AD 144293).** On the formulation of dynamic-programming processes—IV: on the allocation of bombers and decoys. R. E. Bellman and S. E. Dreyfus. 5-2-57. Unclassified.

An extension of RM-1800, *Concerning the Allocation of Decoys To Minimize Bomber Losses*, which described the allocation of decoys to bomber strikes to saturate the defense and decrease losses. The present study shows that the type of problem treated in RM-1800 can be solved quickly by dynamic-programming processes. Problems are considered (1) where the quantities of bombers and decoys, or live missiles and dummy missiles, are given, and (2) where the funds are available to purchase both types of weapons. 10 pp.

- **RM-1900 (AD 133032). Visual detection of light sources on or near the moon.**
S. H. Dole. 5-27-57. Unclassified.

Estimates of the minimum size of man-made light sources on or near the moon that would be visible by telescope to an observer on earth. The specific cases considered comprise diffusely reflecting bodies, specularly reflecting objects, fixed light emitters, and single flashes against backgrounds of various brightness levels. 47 pp. Illus.

- **RM-1901 (AD 123556). On the computational solution of dynamic-programming processes—IX: a multistage logistic-procurement model.** R. E. Bellman and S. E. Dreyfus. 5-6-57. Unclassified.

An application of dynamic programming to multistage logistic problems. The optimal procurement of a replacement part, assuming stochastic demand, is analyzed to determine an initial-order quantity and a replacement schedule that minimize expected cost. Cost factors include purchase cost, storage cost, and outage penalty. 8 pp.

- **RM-1904 (AD 150651). Dynamic programming and stochastic control processes.**
R. E. Bellman. 5-10-57. Unclassified.

An application of the functional-equation technique of dynamic programming to a version of the control process problem where optimal feedback control is determined to neutralize the effect of "noise," i.e., of random disturbance. In particular, a system S is considered specified at any time t by a finite-dimensional vector $x(t)$ satisfying a vector differential equation $dx/dt = f(x, r(t), v(t))$, $x(0) = c$. It is assumed that c is the initial state, $r(t)$ is a random forcing term possessing a known distribution, and $v(t)$ is a forcing term. 11 pp. See revision P-1003. Incorporated in R-350. Also incorporated in a book entitled *Adaptive Control Processes: A Guided Tour*, published by Princeton University Press, Princeton, New Jersey, 1961. \$6.50.

- **RM-1905 (AD 133026). The moments of two limiting distributions of Kolmogorov.**
H. P. Edmundson. 4-15-57. Unclassified.

A derivation of a general expression for the i th moment of two limiting distributions due to A. Kolmogorov. In addition, the dispersions of these two distributions are compared. 12 pp. Also published as P-1475. See also RM-1820 and RM-1958.

- **RM-1906 (AD 123547). An addendum to previous USSR-U.S. retail price comparisons.** N. M. Kaplan and E. S. Wainstein. 5-13-57. Unclassified.

A supplement to RM-1692-1, *A Comparison of Soviet and American Retail Prices in 1950*. This study used inappropriate Soviet weights to compute average ruble-dollar retail price ratios, and a recently published Soviet statistical handbook on trade makes it possible to construct more accurate sets of weights. The authors have recomputed the average ruble-dollar price ratios with the new weights and found that the previous results in connection with all commodities and services were not appreciably affected. 3 pp. Table.

- **RM-1913-AEC (AD 133043). Space plots of pressure, density, and particle velocity for the blast wave from a point source in air.** H. L. Brode. 6-3-57. Unclassified.

Supplementary reference data for RM-1824-AEC, *Point Source Explosion in Air*. The present study contains graphs of pressure, density, and particle velocity versus radius at specified times throughout the course of an explosion in air originating from an instantaneous release of energy at a point. 52 pp. Illus.

- **RM-1916 (AD 237789). Data for testing a model of organizational behavior.**
R. L. Chapman. 3-1-60. Unclassified.

A collection of experimental evidence assembled from three air-defense experiments, which were conducted between 1952 and 1956 to investigate the design and management of large-scale man-machine systems. Although the air-defense direction center is selected for study as a man-machine system, the publication contributes to organization theory, not to air defense. It describes the objectives, nature, and experimental design of the studies carried out in the Systems Research Laboratory and presents a conceptual framework for investigating organizational behavior. In addition, it makes most of the accumulated data available to the Air Force and to scientists elsewhere engaged in the study of organization theory. 195 pp. Illus.

- **RM-1917-1 (AD 237611). The game Monopologs.** J. R. Renshaw and A. Heuston. 7-17-57. Rev. 3-31-60. Unclassified.

A discussion of the inventory-management game, Monopologs, which simulates a part of the Air Force supply system. The study describes the game's evolution and philosophy, its rules, a sample run using the demand pattern generated for the original version of the game, and two methods by which the player can generate his own demand pattern as the game proceeds. 37 pp. See also RM-2086 and RM-2455.

- **RM-1919 (AD 144262). Prices of basic industrial goods in the USSR, 1950 to 1956: a preliminary report.** E. L. Turgeon and A. Bergson. 6-12-57. Unclassified.

A continuation of P-789, which measured wholesale price movements for basic industrial products in the USSR from 1928 to 1950. The present study extends these calculations from 1950 to 1956. Index numbers of wholesale prices are compiled for twenty-six basic industrial branches, for six groups of these branches, and for basic industrial goods generally. Value weights for 1937 are used in aggregating price relatives and branch indices. The period studied represents the first extended period of general decline of industrial prices since the inauguration of the Soviet five-year plans. 86 pp. Tables.

- **RM-1922 (AD 133018). A casebook on Soviet astronautics: part II.** F. J. Krieger. 6-21-57. Unclassified.

A two-part bibliography of Russian books and periodicals dealing with various aspects of rocketry and astronautics. In addition, this study contains a series of complete translations from the Russian of articles and papers which show the singleness of purpose in the Soviet space-flight program. 211 pp. Illus. Superseded by R-311 (out of print). Incorporated in a book entitled *Behind the Sputniks: A Survey of Soviet Space Science*, published by the Public Affairs Press, Washington, D.C., 1958. \$6.00.

- **RM-1923 (AD 133016). Production characteristics of Hi-Valu airframe spare parts.** A. J. Rehkop. 6-19-57. Unclassified.

An examination of the manufacturing processes of a selected group of Hi-Valu airframe spares and of some opportunities for increased flexibility in supply through the use of buffer stocks. The major types of spares (continuous production spares, periodic production spares, and vendor items) are examined, and in particular the group of Hi-Valu airframe spares on the F-104 Starfighter are considered. It is concluded that the ratio of continuous production parts to periodic production parts for complete spares and the very different ratio for components influence decisions on the composition of a buffer stock. 27 pp. Tables.

RM-1924 (AD 133010). First tooling-up exercise for Logistics Systems Laboratory (October–November, 1956). Logistics Systems Laboratory, Economics Division. 7-1-57. Unclassified.

A description of PROLOG I, an L.S.L. exercise designed to evaluate better procurement and distribution methods for airframe spare parts. The experiment attempted to determine whether its results, if applied to a reasonably complex simulation of the logistics system, were better than the methods used by the Air Force. PROLOG I is of historical interest in recording the beginnings of RAND's Logistics Systems Laboratory. 45 pp. Illus. See supplement RM-1961.

- **RM-1926-RC. NATO deterrent vs. shield.** M. W. Hoag. 6-13-57. Unclassified.

A discussion of the argument within NATO for supplementing strategic air forces with strong tactical forces for total war. The disadvantages are that tactical forces do not contribute greatly toward deterring or fighting total war, their cost imposes military sacrifices elsewhere, better air defenses may be more effective, and our European allies may have little incentive to supply tactical forces. However, in the case of a sharply limited war in Europe, tactical forces have renewed utility, with strategic air forces complementing tactical forces as the necessary enforcer of weapon limitations. 32 pp.

- **RM-1930 (AD 133013). Soviet agricultural marketings and prices, 1928-1954.** J. F. Karcz. 7-2-57. Unclassified.

Part of a broader investigation expected to obtain price index numbers for deflating national income accounts prepared in terms of current rubles. The present study attempts to show index numbers of Soviet agricultural prices from 1928 to 1954. By comparing the prices received by the farmer with the prices he must pay for retail goods and services, it is suggested that relative to the city worker, the peasant is as well off now as he was in 1928. 513 pp. Tables.

- **RM-1933 (AD 133008). Utilization of a moon-rocket system for measurement of the lunar magnetic field.** E. H. Vestine. 7-9-57. Unclassified.

A summary of current research concerned with the use of measurements of the moon's magnetic field in studies of the moon and its history. An instrument is described which would operate on the surface of the moon and measure the magnitude, distribution, and other characteristics of the moon's magnetic field. 29 pp. Table. See also RM-1764 and RM-2106.

- **RM-1934-RC. A case study in the measurement of government output.** W. A. Vogely. 7-9-57. Unclassified.

An examination of the Bureau of Land Management, United States Department of Interior, that seeks to identify Bureau outputs and to value them, wherever possible, in terms directly commensurate with inputs. Minerals, land grazing, and forestry programs are examined for this purpose and to appraise their efficiency. The general aim throughout is to demonstrate the feasibility of such case studies, and methodological implications are stressed. 185 pp. Illus.

- RM-1937 (AD 133035). Ten common pitfalls.** H. Kahn and I. Mann. 7-17-57. Unclassified.

A draft of a chapter of a proposed book on military planning in an uncertain world. The present study identifies and discusses some of the common mistakes made by operations analysts and systems analysts. The authors summarize such pitfalls as modelism, statistical and real uncertainties, over-concentration, phasing, overambition, fanaticism, and hermitism. 64 pp. Illus. See also RM-1829-1 and RM-1880.

- **RM-1939 (AD 133017). Fully cavitating hydrofoils in nonsteady motion.** B. R. Parkin. 7-8-57. Unclassified.

A presentation of a small-perturbation theory in two dimensions for the nonsteady flow past an isolated, submerged, fully cavitating flat plate inclined at a small angle to the oncoming steady stream. A more general theory is discussed for cavitation numbers greater than zero. In addition, numerical values for the frequency response and the indicial admittance are given for vertical translatory motions. 79 pp. Illus.

- **RM-1941 (AD 133021). Artificial satellites of the moon.** R. W. Buchheim. 6-14-56. Unclassified.

A discussion of the requirements for establishing an artificial satellite of the moon. Such problems are considered as general orbit properties, limiting orbit parameters, transporting the satellite to the moon, attitude control during transit, and the visibility of the satellite on orbit. 90 pp. Illus. Also published as P-873.

- RM-1947 (AD 133024). Khrushchev and the political crisis of June, 1957.** Myron Rush. 7-23-57. Unclassified.

A study of Khrushchev's bid for power since Stalin's death, and particularly since January, 1955. The June days of 1957 were the climax of the developing crisis within the collective leadership which was brought on by Khrushchev's efforts to establish his hegemony over party and country. The outcome of these events not only demonstrated the high degree of power already possessed by Khrushchev, but added immeasurably to it. It is concluded that should Khrushchev prove unable to cope with the serious problems he now faces, a new succession crisis may arise. 53 pp. Also published as P-1135. See also RM-1883 and P-1146. Incorporated in *The Rise of Khrushchev*, Public Affairs Press, Washington, D.C., 1958. \$3.25.

- **RM-1948 (AD 133027). Political trends in the Hungarian army, 1945-1956.** István Szent-Miklós. Trans. by Paul Kecskemeti. 7-23-57. Unclassified.

An account written by a former Hungarian officer on the various political currents and counter-currents in the Hungarian army from 1945 to 1956. The sovietization of the postwar Hungarian army is distinguished by (1) the reconstruction of the army after the war under actual but unavowed communist leadership, (2) the transformation of the army into a "People's Army," a process characterized by both numerical expansion and emphasis on the "popular" class origin of the cadres, and (3) the full sovietization of the Hungarian armed forces when István Bata became Minister of Defense in July, 1953. However, when the revolution occurred in Budapest in October, 1956, the army deserted the communist regime. 82 pp.

- **RM-1949 (AD 133020). The changing pattern of Soviet foreign policy.** R. C. Tucker. 7-23-57. Unclassified.

An attempt to interpret the sources of change in post-Stalin Soviet foreign policy. The significant developments in the new phase are described as (1) the recovery of flexibility, a broader range of operations and repertoire of techniques, (2) the revival of diplomacy, a willingness to negotiate in certain noncrisis situations, and (3) a "mental thaw," the loosening of certain rigid Soviet attitudes characteristic of the classic period of the cold war. In addition, the implications of these changes on future USSR strategy in cold war are examined. 29 pp. See also RM-1881.

- **RM-1956 (AD 150658). Note on the Sr⁹⁰ hazard.** A. L. Latter and M. S. Plesset. 1-31-58. Unclassified.

An examination of experimental data concerning the progress of Sr⁹⁰ from a nuclear explosion into the human body to obtain an evaluation of the biological hazard. An attempt is made to determine the number of deaths from bone cancer and leukemia expected per megaton of fission energy exploded. Although the quantity estimated by the Federation of American Scientists is 500 to 2000 expected deaths per megaton, the number obtained in this study is about 200. 13 pp. See also RM-2409.

- **RM-1958 (AD 133023). The moments of two distribution-free statistics of Smirnov.** H. P. Edmundson. 7-15-57. Unclassified.

A derivation of a general expression for the *i*th moment of two distribution-free statistics due to N. Smirnov. 11 pp. Table. Also published as P-1476. See also RM-1820 and RM-1905.

RM-1961 (AD 133036). Second tooling-up exercise of Logistics Systems Laboratory (January-February, 1957). Logistics Systems Laboratory, Economics Division. 8-19-57. Unclassified.

A supplement to RM-1924, *First Tooling-up Exercise of Logistics Systems Laboratory (October-November, 1956)*. The present study attempts to determine whether a revised logistics system, incorporating changes proposed by RAND and by the Air Force which relate to provisioning, distribution, and data processing of airframe parts, will give equal or greater support at lower cost. The simulation techniques used in this second exercise (PROLOG II) will have a role in the first Laboratory Problem (LP-I), including the setting up of the two logistics systems on the laboratory floor, the use of time compression, and the calculation of system costs. 112 pp. Illus.

RM-1962. Stockage policies for medium- and low-cost parts. A. R. Ferguson and L. Fisher. 4-18-58. Unclassified.

A method for determining base and depot stock levels in the face of the dynamic and uncertain environment with which the Air Force supply system has to deal. The method examines the major variables which must be considered to achieve economical and effective provisioning and distribution under such circumstances. The study indicates what stockage rules should include, how the dynamics of weapon-system or other program phase-in or phase-out can be taken into account, how to free management to manage better the more costly and critical items, what further research is needed, and how the application of these as well as other supply policies can be improved. 158 pp. Illus.

- **RM-1963 (AD 133046). Design procedures and data for sandwich panel tests.** L. E. Kaechele. 8-13-57. Unclassified.

A discussion of tests for determining whether the weight advantages theoretically provided by flat, simply supported, honeycomb-core sandwich panels in uniaxial compression are attainable in practice. The procedure for the design of test panels with optimum properties is demonstrated with examples, and design data are given for aluminum and titanium sandwich panels. 44 pp. Illus.

- RM-1965 (AD 144302). A calculation of the blast wave from a spherical charge of TNT.** H. L. Brode. 8-21-57. Unclassified.

The solution, on a high-speed computer, of the partial differential equations of hydrodynamic motion for the case of a center-detonated spherical charge of TNT. Results are shown principally in graphical form, in which the second shock is seen to originate as an imploding shock following the inward rarefaction into the TNT gases. A series of minor shocks are generated in the same manner and are seen to move out in the negative phase behind the main shock. 63 pp. Illus. See revised version P-975.

- **RM-1967 (AD 133040). The intense stress field produced in the elastic earth by a bomb blast at the surface.** Hyman Serbin. 8-23-57. Unclassified.

A theory for determining the free stress field in the earth caused by a bomb blast at the surface. It is assumed that the earth is an elastic solid. The analysis is confined to the intense stress field developed shortly after the burst. Stresses and displacements are calculated which can be compared with test data when available. 41 pp. Illus. Also published as P-1210.

- **RM-1969 (AD 133028). Radioactive contamination from a multibomb campaign.** S. M. Greenfield. 1-6-56. Unclassified.

A method for determining the radioactive contamination from a campaign involving many atomic or thermonuclear weapons detonated in a relatively limited area. It is assumed that bombs of the same yield are dropped simultaneously and at random within the given area. The results are presented graphically for a wide range of yields, areas, and numbers of bombs. 36 pp. Illus. See also R-309.

- RM-1972 (AD 150687). On the stability of flow in the boundary layer near the nose of a blunt body.** A. M. Kuethe. 8-28-57. Unclassified.

An investigation of the stability of flow in the boundary layer near the nose of a blunt body. The analysis indicates that (1) the stretching of vortex filaments—because of the change in body cross-sectional area and the positive velocity gradient near the nose—is a destabilizing influence on the flow in the aerodynamic boundary layer, and (2) the destabilizing influences of stretching and of surface cooling on the flow over the convex surface exceed the stabilizing influence of curvature up to a certain distance from the nose. 16 pp. Illus.

- **RM-1973 (AD 150699). A systematic approach to a class of problems in the theory of noise and other random phenomena.** A. J. F. Siegert and D. A. Darling. 9-4-57. Unclassified.

The development of a perturbation formalism which relates the solutions of the integral equations belonging to two different functions $\Phi(X, \tau)$. If the transition probability density for $X(\tau)$ is the principal solution of two partial differential equations of the Fokker-Planck-Kolmogoroff type, the principal solution of two similar differential equations is the solution of the integral equations. Integral equations with a single variable are discussed, and several examples of quadratic functions of a stationary, n -dimensional, Markoffian Gaussian random process are presented. 81 pp.

- **RM-1974 (AD 206491). Theoretical solutions of spherical shock-tube blasts.** H. L. Brode. 9-4-57. Unclassified.

A description of the results of calculations on two types of explosions which correspond to recent experimental work at the University of Toronto Institute of Aerophysics. These experiments involve the explosion of gas-filled glass spheres (initially) at room temperature and at pressures of around twenty atmospheres. 78 pp. Illus.

- **RM-1976 (AD 144278). Notes on linear programming—part XLIII: a feasibility algorithm for one-way substitution in process analysis.** K. J. Arrow and S. M. Johnson. 9-12-57. Unclassified.

A proof that an algorithm for the most efficient assignment of machines to tasks solves an equivalent linear-programming problem. The study assumes that with a certain number of machines (not all of the same capability) with which to do a certain number of tasks (not all of the same difficulty), it is better to use a more capable machine for a more difficult task. 14 pp. Also published as P-941.

- **RM-1977 (AD 144263). Notes on linear programming—part XL: network flow and systems of representatives.** L. R. Ford, Jr., and D. R. Fulkerson. 9-12-57. Unclassified.

Part of a broader investigation concerned with the maximal logistic flow in a railroad network and in the military interdiction of that flow. The present study extends a theorem of Hall, which gives necessary and sufficient conditions for the existence of a system of distinct representatives. The network-flow theory is then applied to generate necessary and sufficient conditions for (1) the existence of a system of restricted representatives and (2) the existence of a common system of restricted representatives for two different collections of subsets of the fundamental set. 19 pp.

- **RM-1978 (AD 133044). Resolution of real-coefficient polynomials in control system analysis.** W. H. Shields. 8-20-57. Unclassified.

A discussion of several different approaches to the problem of numerical root-extraction as encountered in control system analysis. Three distinct techniques are treated: (1) a method based on continuity, (2) an extension of the Lin method, and (3) the use of "undetermined coefficients." Optimal mix of the methods for greatest efficiency in practice is indicated. 44 pp.

- **RM-1981 (AD 144279). Notes on linear programming—part XLI: constructing maximal dynamic flows from static flows.** L. R. Ford, Jr., and D. R. Fulkerson. 9-17-57. Unclassified.

An outline of a method for constructing maximal dynamic flow from static flow and a presentation of a simple proof of maximality. It is assumed that for a given network of nodes and arcs (e.g., a railway system) each arc has associated with it two positive integers. These integers consist of a commodity-flow capacity and a commodity-traversal time. 36 pp. Illus. Also published as P-967. See also RM-2152.

- RM-1985 (AD 150675). A vulnerability model for weapon sites with interdependent elements.** S. I. Firstman. 9-4-57. Unclassified.

A description of a simple "counting" model, using overlays and circular probability grids. An attempt is made to determine the trade-off, measured in survival probability, between site dispersal and hardening for a weapon-system complex composed of several interdependent elements which are separated by distances of less than two lethal radii. An example of vulnerability estimation by the use of the model is included. 29 pp. Illus.

- **RM-1986 (AD 133033). A comparison of construction costs in the USSR and U.S.** N. M. Kaplan. 9-23-57. Unclassified.

A description of and commentary on a comparative study, made by the Stanford Research Institute, which attempts to obtain ruble-dollar price ratios for construction. The ratios are surprisingly low, and reasons are given why they are probably too low. Additional studies to check these ratios, and an alternative approach to the problem of comparison, are suggested. 85 pp. See also RM-1443 and RM-2432.

- **RM-1991 (AD 144284). Sweepback theory for shock waves at hypersonic speeds.** J. D. Cole. 10-2-57. Unclassified.

Results (given by hypersonic small-deflection theory) for the pressure coefficient, density, and other characteristics behind the shock wave on a sweepback wedge. A comparison with exact theory can be made, at infinite Mach number, to show that the hypersonic small-deflection theory yields very good results out as far as sweepbacks sufficiently large to cause detachment. 14 pp. Illus. Also published as P-1337.

- RM-1992 (AD 133049). "Contradictions" in the Moscow-Peking axis. A. S. Whiting. 9-24-57. Unclassified.

An examination of the military, economic, and ideological interaction between the Soviet Union and the People's Republic of China from 1955 to 1957. Placed against the first 5 years of the Sino-Soviet alliance, trends of changing relationships caused by Stalin's death and the Korean armistice are projected for probable developments in the near future. The military, economic, and ideological factors considered operate within the confines of the alliance in terms of the relative positions of the partners vis-à-vis each other. In addition, they exist in a world situation as viewed from Peking and Moscow, juxtaposing the position of the partners against their perceived opponents. 66 pp. Also published as P-1183. Published in the *Journal of Politics*, February, 1958.

- RM-1993 (AD 133048). Logistics Laboratory Problem I after two (simulated) years. Stephen Enke. 10-10-57. Unclassified.

An examination of the first two simulated years of Laboratory Problem I of RAND's Logistics Systems Laboratory, conducted to test an experimental set of logistics policies and procedures (Logistics System 2) for operational feasibility and to compare the performance of this system with another set of policies (Logistics System 1) based on recent and current Air Force practice. The two logistic systems in the laboratory have "flown" the same number of flying hours. Results to date show that LS-2 has fewer AOCP's, about the same AOCP's, and more ANFE's than LS-1, and that LS-2 is considerably less costly than LS-1. 26 pp. Illus.

RM-2006 (AD 150665). Rate of fall through the atmosphere of irregularly shaped particles. R. R. Rapp and J. D. Sartor. 11-1-57. Unclassified.

A discussion of a method used to determine experimentally the rate of fall for atmospheric particles of irregular shape. The results of the tests are given, and are compared with earlier experiments and theoretical approximations. 15 pp. Illus. Also published as P-1830.

- RM-2008 (AD 144282). Theory of the solar aureole—part I: scattering and radiative transfer. Diran Deirmendjian. 10-3-57. Unclassified.

A discussion of a theory of the clear-sky aureole around the sun as a problem of radiative transfer in a plane-parallel, scattering atmosphere. Applications of the theory to the skylight in the immediate vicinity of the sun will be considered in a subsequent study. 40 pp. Illus. Also published as P-1190. See also RM-2133.

RM-2010-AEC. Free-free Gaunt factors. W. J. Karzas and R. Latter. 11-8-57. Rev. 10-3-58. Unclassified.

A computation of the hydrogenic (unscreened coulomb) free-free gaunt factors for a wide range of initial energies and photon frequencies. In addition, an average over initial energies with the Maxwell-Boltzmann distribution is performed to give the temperature-averaged Gaunt factors for use in opacity calculations. These are presented as functions of Z^2/kT and $h\nu/kT$. The relation between these Gaunt factors and the rate of Bremsstrahlung energy production is given, as is the total energy emitted as a function of Z^2/kT . 22 pp. Illus.

- RM-2011 (AD 144288). On the strength of fine wires. F. R. Shanley. 9-26-57. Unclassified.

A theory concerned with the exceptionally high tensile strength of fine wires. The theory assumes that the "core" material of the wire slips at nominal stress, while the "skin" slips only at very high tensile stress. In very fine wires the fraction of total cross section represented by the "skin" becomes large enough to increase appreciably the tensile strength of the wire. Suggestions for further research and testing are given. 21 pp. Illus. See revision P-1654. See also P-68.

RM-2013 (AD 144298). Electronic data-processing control of Air Force spare-parts inventories. S. L. Pollack. 11-14-57. Unclassified.

A description of the functional steps required to control Air Force inventories of spare parts and an explanation of the exercise of these functions in the context of an electronic data processing system, such as the Air Force seeks to develop. The ways and means of applying electronic data processing equipment (EDPE) to Air Force inventory control are illustrated. This study may be

of interest to management people who are responsible for controlling spare parts inventories and to appropriate specialists in such fields as statistical services, supply, and systems development personnel. 131 pp. Illus. See also RM-1417, RM-1639-1, RM-2232, and RM-2269.

- **RM-2021 (AD 150661). Notes on linear programming—part XLII: linear programming and structural design.** William Prager. 12-3-57. Unclassified.

A discussion of (1) "limit analysis," which provides the structural engineer with an estimate of the load-carrying capacities of structures made of ductile materials, and (2) "limit design," which guides the structural engineer toward an economic design of structures made of ductile materials and carrying specified loads. From the mathematical viewpoint, these problems can be reduced to problems in linear programming. Methods for their solution are presented, together with a sketch of the historical development of limit analysis and design. 51 pp. Illus.

- RM-2057-2. A preliminary examination of single-sideband communications.** W. K. Squires. 6-14-57. Rev. 4-20-59 and 1-8-60. Unclassified.

An examination of the comparative advantages of single-sideband (SSB) and competing modulation methods (amplitude modulation, double-sideband) from the standpoints of performance, cost, volume and weight, spectrum use, and anticipated reliability. This investigation is primarily concerned with HF voice considerations, with emphasis on current and impending USAF applications. In addition, the author discusses the implications of extensive SSB usage (at present for voice) in a communications environment in which the trend is toward increased data transmission. 68 pp. Illus.

- **RM-2060 (AD 150666) (out of print). Studies in machine translation—2: research methodology.** H. P. Edmundson and D. G. Hays. 12-16-57. Unclassified.

A discussion of the research methods for machine translation of language now in use at RAND. This methodology is a system for preparing foreign-language text on punched cards, for producing translations in analyzable form, and for exposing semiautomatically the relationships between the original and translated versions so that the entire process of machine translation can be improved by successive refinements. 24 pp. Illus. Also published as P-1251.

- **RM-2061 (AD 150668). Studies in machine translation—5: manual for keypunching Russian scientific text.** H. P. Edmundson, D. G. Hays, E. K. Renner, and R. I. Sutton. 12-13-57. Unclassified.

Part of a broader investigation concerned with the methods used at RAND for research on machine translation. The present manual attempts to assist keypunch operators in preparing text cards from Russian scientific text. It is assumed that the text has been edited before it reaches the keypunch operator. Such topics are considered as card and keyboard layouts, punctuation, and special codes and symbols. In addition, other RAND studies in machine translation are listed. 10 pp. Illus. See also RM-2063–RM-2066-1, RM-2068, RM-2069, RM-2538, and RM-2655.

- RM-2062 (AD 144287). Experimental design and evaluation of an F-86H flyaway kit.** D. M. Fort. 12-18-57. Unclassified.

A study which describes a flyaway kit design procedure developed at RAND and shows its experimental application to the design of an F-86H flyaway kit. This procedure attempts to systematize the treatment of numerous factors (e.g., the combat unit to be supported, the period of support, available maintenance facilities and personnel, flyaway kit size limitations, and various spare parts characteristics) and to help develop more effective and economical flyaway kits. It is concluded that the RAND flyaway kit design methodology may provide significant improvements over current Air Force procedures. 84 pp. Illus. See also RM-1490 and RM-2233.

- **RM-2063 (AD 150672). Studies in machine translation—1: survey and critique.** H. P. Edmundson, K. E. Harper, and D. G. Hays. 2-25-58. Unclassified.

A review of the progress in research and development on the application of high-speed digital computers to language translation (e.g., Russian to English). An attempt is made to determine (1) how machine translation can be accomplished, (2) what the principal achievements are thus far, and (3) what more is required. Machine translation (MT) is defined as the art of translation from one natural language into another by means of an automatic computer. 28 pp. See also RM-2061, RM-2064–RM-2066-1, RM-2068, RM-2069, RM-2538, and RM-2655.

- **RM-2064 (AD 156048). Studies in machine translation—3: résumé of machine codes and card formats.** H. P. Edmundson, D. G. Hays, and R. I. Sutton. 8-18-58. Unclassified.

One of a series of studies concerned with computer application to language translation. This study, of interest to system and procedure designers, describes the punched-card layouts and codes that facilitate manipulation of language data in computers. 32 pp. Illus. Also published as P-1352. See also RM-2061, RM-2063, RM-2065, RM-2066-1, RM-2068, RM-2069, RM-2538, and RM-2655.

- **RM-2065 (AD 231066). Studies in machine translation—4: manual for pre-editing Russian scientific text.** D. G. Hays, E. K. Renner, and D. V. Mohr. 12-4-59. Unclassified.

One of a series of studies describing the methods now in use at RAND for translation by computers from Russian to English. The first of the series (RM-2060, withdrawn) discusses the general approach to machine translation, as well as its philosophy and method. Other publications (RM-2061, RM-2063, RM-2064, RM-2066-1–RM-2069, RM-2538, and RM-2655) describe subsequent operations in the research process. This manual is designed to assist editors in maintaining uniform rules and standards in the preparation of Russian technical literature for keypunching. The study should be of interest to those concerned with computer technology and with the application of computers to language processing. 38 pp. Tables.

- **RM-2066-1 (AD 253635). Studies in machine translation—6: manual for coding Russian grammar.** K. E. Harper, D. G. Hays, and D. V. Mohr. 3-3-58. Rev. 12-29-60. Unclassified.

One of a series of studies on the technical aspects of the linguistic analysis of Russian text. This research memorandum describes a basic classification of Russian forms according to their inflections, or spelling changes. The manual also discusses a classification by syntactic properties, based on the possibilities for connection of the coded form with others in text. 87 pp. See also RM-2061, RM-2063–RM-2065, RM-2068, RM-2069, RM-2538, and RM-2655.

- **RM-2068 (AD 249679). Studies in machine translation—8: manual for postediting Russian text.** K. E. Harper, D. G. Hays, and B. J. Scott. 7-15-60. Unclassified.

One of a series of RAND publications on machine translation. The study discusses "postediting," which refers to the analysis of partially machine-translated Russian text for system errors. The posteditor encodes whatever changes are required in the text, produced by the machine, to obtain an accurate, readable English equivalent. In preparation for linguistic analysis, he also encodes necessary corrections to the machine-generated structural analysis of each sentence. His changes reveal—in the manner of a feedback control mechanism—the shortcomings of the machine-translation program. The objective of the research process is to reduce or conceivably to eliminate the work of the posteditor. 45 pp. Tables. Also published as P-1624. See also RM-2061, RM-2063–RM-2066-1, RM-2069, RM-2538, and RM-2655.

- **RM-2069 (AD 210147). Studies in machine translation—9: bibliography of Russian scientific articles.** H. P. Edmundson, K. E. Harper, D. G. Hays, and A. M. Koutsoudas. 10-16-58. Unclassified.

One of a series of studies describing computer applications to language translation. The present research memorandum is a catalogue of the Russian scientific articles currently available at RAND in punched-card form. Six corpora of physics and two of mathematics comprise altogether 225 articles, totaling 227,752 running words. This study may be of particular interest to system and procedure designers who require textual material for research or test purposes. 36 pp. Table. See also RM-2061, RM-2063–RM-2066-1, RM-2068, RM-2538, and RM-2655.

- **RM-2075 (AD 144294). Soviet administrative controls during the siege of Leningrad.** Leon Gouré. 12-23-57. Unclassified.

Part of a broader investigation to determine the vulnerability of the Soviet government's political and administrative control system. The present study describes how the Soviet administration and

the population of Leningrad reacted to the German assault on, and subsequent siege of, Leningrad from 1941 to 1943. It is concluded that at no time were the leadership's political or administrative controls dangerously weakened nor were they ever seriously challenged by the population. 85 pp. See also RM-788.

RM-2077 (AD 150654). Strong-shock point-source blast wave in a non-uniform atmosphere. Norman Austern. 9-9-57. Unclassified.

An approximate calculation of the effect of very large blasts being distorted by the decrease of atmospheric density with altitude. The snowplow model is used. It is shown that the effects are important only for bombs of extremely large yield. In addition, a comparison with the results of the constant-pressure assumption is given. 35 pp. Illus.

RM-2078 (AD 150681). The production of aerodynamic forces by heat addition on external surfaces of aircraft. W. W. Willmarth. 12-30-57. Unclassified.

A development of an equivalence between a fluid-mass source, a heat source, and streamwise body forces within the framework of linearized flow theory. Examples for a two-dimensional flat plate, a delta wing, an axially symmetric slender body, and a wedge-shaped afterbody are computed at subsonic and supersonic speeds. 44 pp. Illus.

RM-2080 (AD 144309). A method for evaluating environmental effects on military operations. J. D. Sartor. 12-21-57. Unclassified.

A method for incorporating the effects of environment on the elemental actions of a military operation into an evaluation of the effect on the entire operation. Particular attention is given to gradations in the weather and their effects on parts of the operation. 35 pp. Illus. See also RM-2322 and P-1895.

● **RM-2085 (AD 144297). Savings from procurement deferral with interim contractor support: the case of high-value airframe spares.** J. W. Petersen. 1-10-58. Unclassified.

An evaluation of the deferred spares procurement concept, a system in which major spares buys are delayed or deferred until later in the program, after support experience is obtained. This study identifies and quantifies the savings and cost elements that would be involved in operating a deferred procurement system, and it considers the impact on supply effectiveness. The investigation is based on an analysis of a sample of high-value airframe spares chosen from three current aircraft models, the B-47, B-52, and F-100. 119 pp. Illus. See supplement RM-2182.

RM-2086 (AD 144295). Baselogs: a base logistics management game. L. Gainen, R. A. Levine, and W. H. McGlothlin. 1-8-58. Unclassified.

A description of Baselogs, a game which demonstrates the interactions between logistics and operations on a fighter-interceptor air base of the ADC type. The player assumes the composite role of director of finance at USAF and command level, as well as director of base-level operations, supply, and maintenance at a simulated ADC-type base. The game may be used as a demonstration tool and, in addition, may be valuable in further research on maintenance-operations interactions. 20 pp. Illus. See also RM-1917-1 and RM-2455.

RM-2088 (AD 144299). A priori demand prediction: a case study of B-52 airframe parts. T. A. Goldman. 1-10-58. Unclassified.

A study which deals with predicting the demand for airframe parts in the absence of consumption data to determine whether the level of demand is related to physical and operational characteristics of parts. In particular, an attempt is made to predict the demand for B-52 airframe spare parts with the help of B-47 consumption experience. The results of these tests are then compared with the reported consumption of the same parts during the early phase-in of the B-52 weapon system. In addition, some of the theoretical foundations for the concept of service-life factors are discussed, together with the relationship of these to the demand predictions in the present study. 39 pp. Tables. See also R-292.

- Ø RM-2091-AEC (AD 205873). **Hydrogenic bound-free Gaunt factors.** W. J. Karzas and R. Latter. 1-15-58. Unclassified.

A computation of the Gaunt factors for bound-free absorption in a pure coulomb field for bound states through the 15 shell and for free electron energies E/Z^2 from 2.5×10^{-3} to 4×10^4 Rydbergs. The results are presented in tables and graphs, and include the Gaunt factors averaged over a complete shell. 39 pp. Illus.

- Ø RM-2092-AEC (AD 150673). **Relativistic oscillator strengths.** Fredrik Zachariasen. 1-15-58. Unclassified.

The calculation of radiative transition rates between eigenstates of a relativistic electron moving in a central potential. The general formula is derived for arbitrary photon multipole and parity, without neglect of retardation. The reduction to a single integral over the Dirac radial wave functions is made for electric multipole moments. A further simplification gives the explicit formula for electric dipole transitions. 12 pp.

- RM-2096 (AD 144305). **A selected bibliography on economic development and foreign aid.** M. W. Hald. 10-22-57. Unclassified.

A selective bibliography of 1500 items on economic and other aspects of growth and development in underdeveloped areas and on the policies of the United States and other agencies in fostering development. The study is primarily concerned with the period from 1950 through 1957, with the greater emphasis on the last five years. An index by country is included to facilitate finding the items pertinent to a particular area. 103 pp.

- RM-2101 (AD 213477). **Soviet national income and product, 1949-1955.** O. Hoeffding and A. E. Nimitz. 4-6-59. Unclassified.

Part of a broader investigation to determine the real changes in the size and structure of Soviet gross national income and product from 1928 to 1955. The present study gives estimates of the national income and product of the USSR from 1949 to 1955, calculated in current rubles and at established prices. The data considered cover a period of sudden and substantial changes in price levels as well as in the relative price structure. These data for recent years are to be used in conjunction with those from other research to deflate the Soviet national income series to constant prices. The study is primarily of interest to S.U. economy specialists. 223 pp. Tables. See revised data in RM-2544.

- RM-2102 (AD 150679) (out of print). **The Soviet military posture as a reflection of Soviet strategy.** H. S. Dinerstein. 3-24-58. Unclassified.

An attempt to determine the extent to which Soviet armed forces reflect the changes in Soviet strategic conceptions dating from 1954 to 1955 and to show the consistency of the design of Soviet ground, air, and naval forces from 1945 to 1953 with a notion of war in which total mobilization occurs gradually as the war continues. Since early 1955, the official Soviet policy has required readiness to fight a war in which nuclear weapons will be used and has stressed that the side which strikes first enjoys great if not decisive advantages. It is concluded that the Soviet Union is seeking a retaliation-proof capability designed to make the initial nuclear blow, whether or not she is thinking in terms of preventive war. 24 pp. See also R-326 (out of print). Incorporated in *War and the Soviet Union*, Frederick A. Praeger, Inc., New York, 1959. \$5.50.

- RM-2106 (AD 150683). **Evolution and nature of the lunar atmosphere.** E. H. Vestine. 1-29-58. Unclassified.

A discussion of the extent and nature of the lunar atmosphere. Such aspects are considered as (1) internal distribution of lunar temperatures and (2) effects of solar wave radiation and corpuscular radiation on surface and atmospheric temperatures. It is concluded that the lunar atmosphere is no denser than the F_2 -region of earth. 51 pp. Illus. See also RM-1764 and RM-1933.

- RM-2107 (AD 156008). **Drag transformation and reduction for bodies of revolution.** R. P. Johnson. 8-30-57. Unclassified.

A derivation, on a theoretical basis, of the physical characteristics of a class of ring-body configurations. It is shown that, relative to a Sears-Haack body of fineness ratio 15, on a drag-per-unit-volume basis there is a large four-dimensional space, of Mach number, central-body fineness ratio, ring radial-position parameter, and percent extent of laminar flow, for which the potential drag reduction is large. 75 pp. Illus.

RM-2108. Graphical methods for the quantitative prediction of close-in fallout.
J. B. Knox. 1-31-58. Unclassified.

The formulation, as an initial value problem, of the quantitative prediction of close-in atomic fallout in middle latitudes. A case study of the prediction of close-in atomic fallout is presented to show the application of the prediction model developed. The model uses numerical-graphical techniques of integration. 130 pp. Illus.

- **RM-2110 (AD 207661). Wide-band magnetic tape recorder.** Ampex Corporation. 10-1-57. Unclassified.

A study of wide-band magnetic tape recorders, designed to contribute to the development of a magnetic tape device for recording and reproducing a 600-line television image without appreciable loss, with small space and weight requirements. The investigation suggests that further improvements be made in the existing Ampex commercial video tape recorder, and particularly in the recording heads. 81 pp. Illus.

RM-2113-1 (AD 216108). An annotated bibliography of RAND space flight publications. R. W. Buchheim. 2-10-58. Rev. 3-1-59. Unclassified.

The title of this research memorandum describes its aim and content. 13 pp.

RM-2117. Simulated wars in LP-I. R. M. Rauner. 2-17-58. Unclassified.

A study of the simulation of war in RAND's Logistics Systems Laboratory, which presents some of the results obtained in Laboratory Problem I (LP-I). LP-I attempted to compare the performance of two logistics systems through a substantial part of a weapon-system life cycle. Two wars were simulated, the first occurring without warning and the second preceded by a five- (Laboratory) day period of warning and preparation. In both wars the Air Materiel Area, the factory, and the ground transportation system were assumed to have been destroyed. Some bases of the Strategic Air Command were assumed to have been destroyed, and their tenant Air Defense Command aircraft lost. 42 pp. Illus.

- **RM-2118-AEC (AD 150692). New developments in the theory of pressure broadening.** Michel Baranger. 2-19-58. Unclassified.

An investigation into various branches of the theory of pressure broadening by solving two problems: that of treating the motion of quantum mechanical perturbers and that of overlapping lines. Both problems are solved only in the impact approximation, but this is adequate when the perturbers are electrons, which is the practical case. In addition, the validity conditions of this approximation are examined. 172 pp.

- **RM-2124 (AD 211641). A comparison of random and periodic data sampling for the detection of signals in noise.** David Middleton. 1-4-58. Unclassified.

An analysis, by means of probability theory, of the effect of using random rather than periodic sampling in radar detection systems. In the specific examples examined, it is found that periodic sampling gives the better performance. 51 pp. See abridgment P-1642.

- **RM-2127 (AD 150700). A criterion for choosing sheet tolerances in aircraft materials.** G. A. Hoffman. 3-7-58. Unclassified.

A method for determining "economically optimum" tolerances in aircraft sheets. The procedure consists in (1) evaluating the increased cost of reducing overweight by tightening tolerances and (2) defining broadly the worth to the operator of one pound of eliminated weight to find the economically reducible overweight, which in turn specifies an optimum tolerance. 21 pp. Illus.

RM-2131. Management information for the maintenance and operation of the strategic missile force. D. S. Stoller and R. L. Van Horn. 4-30-58. Unclassified.

An investigation of the planning- and operating-data requirements and information flow patterns for the strategic-missile force. The main function considered is the measurement and control of maintenance-operations interactions that determine launch capability. The study discusses decision areas, data requirements, desirable system characteristics, and one proposed system. The authors suggest that immediate consideration be given to testing the feasibility and desirability of the proposed system in an appropriate Air Force environment. 61 pp. Illus. See also RM-2508.

- **RM-2132 (AD 156031). Additive generation of pseudorandom numbers.** O. A. Gross and S. M. Johnson. 3-18-58. Unclassified.

The calculation of the cycle lengths of sequences of certain special cases of pseudorandom vectors generated by a new addition technique. These cycle lengths are comparable to those obtained by the established multiplicative methods, and relevant theorems are included. A pseudorandom sequence of numbers is defined as a completely determined sequence having some of the more easily tested statistical properties of truly random sequences. 18 pp.

- **RM-2133 (AD 156039). Theory of the solar aureole—part II: applications to atmospheric models.** Diran Deirmendjian. 2-20-58. Unclassified.

A continuation of RM-2008, which discusses a theory of the clear-sky aureole around the sun as a problem of radiative transfer in a plane-parallel scattering atmosphere. The present study shows that the values of skylight intensity computed on the basis of models are in agreement with observations as to brightness gradient, spectrum, and some polarization features. Careful analysis of good aureole data constitutes a sensitive tool of research in investigating atmospheric turbidity at all levels. 65 pp. Illus. Also published as P-1287.

- **RM-2134 (AD 156030). On the computational solution of dynamic-programming processes—XV: an industrial replacement process.** S. E. Dreyfus. 3-26-58. Unclassified.

A discussion of an industrial replacement problem which involves two identical parts of a single machine. This problem, which arose in the tire-manufacturing industry, has been studied by M. W. Sasieni who arrived at a replacement policy shown to be nonoptimal. The present memorandum applies the functional-equation technique of dynamic programming to the problem. Numerical examples are considered; optimal replacement policies are determined. 11 pp. Illus.

- RM-2137 (AD 150684). Optimal employment of tactical air forces in theater air tasks—II: a game-theoretic analysis.** L. D. Berkovitz and M. Dresher. 3-28-58. Unclassified.

A problem concerned with allocating aircraft among three different air tasks—counterair, air defense, and support of ground operations—in a multistrike campaign as a two-sided war game. Previous studies assumed that in any strike of the campaign each plane allocated to air defense prevents one attacking plane from fulfilling its counterair mission. The present research memorandum removes this assumption and derives the optimal strategies as a function of the air-defense kill potential. 18 pp.

- RM-2144 (AD 156002). Factors affecting the experience composition of airmen in USAF job categories: a mathematical approach.** William Gorham. 1-30-58. Unclassified.

A method for measuring the relative importance of the factors which shape the experience mix or composition of the airmen in an Air Force job category. Factors considered are the length of the enlistment period, eligibility for re-enlistment, re-enlistment, retirement, retraining, attrition, force size, and input mix (between recruits and retrainees). The sensitivity of the experience mix to each of these factors except force size is demonstrated by the use of a steady-state model. To show the impact of changing force size on experience composition, an inventory model is used. Prior to the quantitative treatment of the determinants, each is discussed generally in terms of its effect on the average experience level of the force. 45 pp. Illus.

- **RM-2146 (AD 156014). The economics of invention: a survey of the literature.** R. R. Nelson. 4-15-58. Unclassified.

A selective summary of the literature on the economics of invention. Both growing social demand and new scientific knowledge are examined as factors stimulating inventive effort. The comparative importance of the private inventor and the research and development laboratory are appraised. The study stresses the great uncertainties which still surround any inventive effort seeking a significant advance, and investigates how this uncertainty affects management practices in industrial-research laboratories. The general analysis is supported by a number of case studies. 59 pp. Also published as P-1604.

- **RM-2149 (AD 213036). Monte Carlo models for estimating reliability: an exploratory analysis.** S. I. Firstman. 6-5-58. Unclassified.

An analysis of the problem of a priori reliability estimating by means of the Monte Carlo method. The Monte Carlo model considered is used to predict system malfunctions that do not occur through component failure but occur because the entire system performs outside the bounds set by its specifications. It uses the stochastic properties of component performance to evaluate system output. The study demonstrates the usefulness of the method, the validity of the results, the unbiased nature of derived estimates, and the requirements for input data. 42 pp. Illus.

- **RM-2152 (AD 150686). Notes on linear programming—part XLIV: transient flows in networks.** David Gale. 4-11-58. Unclassified.

A study concerned with flows in two-terminal dynamic networks as defined by Ford and Fulkerson (RM-1981). These authors have shown how to construct for each positive integer k a flow ϕ_k that maximizes the amount μ_k shipped from source to sink in k time periods. Their method leads to different functions ϕ_k for different values of k . The present research memorandum shows that the problem can be solved by a single flow ϕ when k maximizes the cumulative amount shipped from source to sink. The conclusion holds even when the capacities and transit times in the network are allowed to vary with time. The results of this study may be applied in analyzing logistics problems involving railway networks. 17 pp. Also published as P-1264.

- RM-2153. Economic replacement policy.** A. A. Alchian. 4-9-58. Unclassified.

An abbreviated version of R-224, *Economic Replacement Policy* (out of print), which presents a practical guide for equipment replacement based on the comparison of present-value costs. The present study contains the general economic principles and illustrative problem. However, those sections devoted to computational methods in R-224 are omitted because of the development, within the past five years, of the superior method of computation known as dynamic programming. 31 pp. Illus.

- **RM-2157 (AD 156005). The big squeeze, or the utility of the heavy presses.** R. W. Smith. 4-14-58. Unclassified.

A study which discusses (1) an improved method of estimating the potential economic savings derived from the use of extruded and forged items from heavy presses and (2) possible new and unique applications for their "big squeeze" capability. The author shows that substantial savings can be obtained from the use of the presses in addition to any savings in fabrication costs. Possible uses of the presses for metallurgical processes, plastics, and quartz, as well as increased use for metal characteristics improvements, are mentioned to stimulate ideas for still greater use of the big equipment. 13 pp.

- **RM-2159 (AD 156011). Notes on linear programming—part XLV: a network-flow feasibility theorem and combinatorial applications.** D. R. Fulkerson. 4-21-58. Unclassified.

An establishment of necessary and sufficient conditions for the existence of a flow in a network (e.g., a railway network) satisfying prescribed bounds on the net flow leaving certain nodes and entering other nodes. These conditions are applied to the study of combinatorial problems concerning matrices of zeros and ones, subgraphs of a directed graph, and systems of distinct representatives. 30 pp. Also published as P-1278.

- **RM-2161 (AD 156043). Outline of a study on extraterrestrial base design.** R. D. Holbrook. 4-22-58. Unclassified.

An outline of foreseen requirements for extraterrestrial bases of various types and of the effect of design requirements on associated space-flight systems. In the context of a lunar-base design, present knowledge of the moon and of rocket-transport problems are considered. In addition, ecological factors, systems of support, operations and hardware, and growth of initial facilities (from both earth and local site) are discussed. 84 pp. Illus.

RM-2163. The Soviet Union and the atom: toward nuclear maturity. Arnold Kramish. 4-25-58. Unclassified.

The concluding chapter of a proposed book on Soviet atomic policy. Based on publicly available materials, this research memorandum describes the progress of the USSR atomic energy program: its organization and the nuclear research institutes serving as training centers, the new atomic communities built for research purposes, atomic and hydrogen bomb development, Soviet applications of nuclear explosions, the construction of reactors and reactor stations, the uses of radioisotope programs, the search for uranium and other rare materials, and the advanced state of nuclear accelerating machines. This investigation reveals that the Soviet Union is eager to venture into untried fields and is willing to give unprecedented financial support to achieve scientific success. 113 pp. See also RM-1711, RM-1896, and P-853. Data revised and incorporated in *Atomic Energy in the Soviet Union*, Stanford University Press, Stanford, Calif., 1959. \$4.75.

RM-2169 (AD 305561). An identification system for use as an aid to raid detection and air traffic control. W. K. Squires. 5-13-58. Unclassified.

A proposed new identification system in which all U.S. aircraft and all ZI penetrating aircraft would be required to carry a transmitter emitting altitude and ID information. This system would enable ground stations to obtain full position information for use in air traffic control and would serve as an aid in raid detection. 47 pp. Illus.

RM-2170-RC. Attitudes of the French parliament and government toward atomic weapons. C. de la Malène and C. Melnik. Trans. by R. Manheim. 5-14-58. Unclassified.

A discussion of the attitudes of the French government and parliament toward atomic weapons since their discovery and use. Part I deals with the historic development of these attitudes (e.g., those ranging from the total absence of nuclear-mindedness to the growth of the atomic weapon issue in the minds of civilians and military alike). Part II describes the causes of the lag in nuclear-mindedness: the "European" controversy, the French parliamentary situation, atomic neutralism, the rules of the French political "game," feelings of incapacity, fear of public opinion, and the changes implied by an atomic arsenal. 80 pp.

- **RM-2172 (AD 156036). A possible transponding system for an artificial asteroid.** P. Swerling and C. M. Crain. 5-14-58. Unclassified.

A means of increasing the precision with which the dimensions of the solar system are known by measuring the transmission-path length to an artificial asteroid by radio-frequency transponding techniques. This study describes the design of a possible pulsed transponding system by which the transmission-path length can be measured with an accuracy limited essentially by the accuracy with which the velocity of light is known. Typical values of range and radial velocity in connection with the earth of the proposed artificial asteroid are assumed. In addition, a weight and volume breakdown of a possible design is given. 40 pp. Illus.

RM-2173 (AD 156012). A review of similitude theory in ground shock problems. B. R. Parkin. 4-22-58. Unclassified.

A review of the available data on the dynamic behavior of soils, analyzing possible theories of soil dynamics. The results of this investigation are used to discuss the applicability of model scaling laws to the solution of ground-shock problems. In addition, the usefulness of model studies as an aid in the evaluation of theories of soil dynamics is considered. 50 pp. Tables. See supplement RM-2486.

- **RM-2174 (AD 205422). Lunar base study jury report: evaluation of an experiment in creative design conducted with college students.** R. D. Holbrook, H. A. Lang, and J. H. Huntzicker. 1-1-58. Unclassified.

An evaluation of an experiment conducted with students of the Creative Engineering course given at M.I.T. in 1956-1957. The experiment consisted in presenting the students with the problem of designing lunar-base facilities under the sole constraint that transported mass be minimized. Five student papers are given, and the worth of the course and the approach are examined. 210 pp. Illus.

- **RM-2175 (AD 156007). Agriculture in communist Germany.** Horst Mendershausen. 5-30-58. Unclassified.

A study of the factors which make the productive agricultural area of the German Democratic Republic unable to feed a declining population, under conditions of improved technology and massive state subsidization. Such aspects are discussed as physical factors and soil use, expropriation and settlement, collectivization, machine-tractor stations, production and delivery planning, the double-price system in agriculture, fertilizer and seed supply, agricultural output, performance of the Socialist sector, and food consumption. 78 pp. Tables.

- RM-2177 (AD 156010). The simulated aircraft and its failure model in LP-I.** W. H. McGlothlin, G. C. Noonan, Jr., G. E. O'Dell, and S. L. Pollack. 5-21-58. Unclassified.

One of a series of research memoranda describing Laboratory Problem I (LP-I), an experiment designed to evaluate a set of proposed logistics policies and procedures by comparing them with another set of policies based on Air Force logistics practices more or less current in mid-1956. In its first major experiment, LP-I simulated the supply and maintenance activities of a logistics system supporting an Air Defense Command aircraft. The present study describes aircraft and failure models (using parts from the F-100D) developed to determine the frequency and pattern of parts failures occurring as a result of flying and maintenance activity. 63 pp. Illus.

- **RM-2178 (AD 156001). Notes on linear programming—part XLVI: bounds on the primal-dual computation for transportation problems.** D. R. Fulkerson. 5-21-58. Unclassified.

One of a series of studies concerned with optimal transportation flow through a network (e.g., through a railway network). Theoretical bounds on the number of labelings required to solve either a transshipment problem or a Hitchcock-Koopmans problem by the primal-dual method are established. These bounds depend on the amount K to be sent through the network and the number N of nodes, but not on the cost function. For the transshipment problem, a bound is $K(N + 1)$. For the Hitchcock-Koopmans problem with m sources and n sinks, this may be sharpened to $K(\min(m, n) + 1)$. 16 pp.

- **RM-2180 (AD 156040). Plastic behavior of thin plates under normal pressure.** F. R. Shanley. 5-22-58. Unclassified.

An analysis, for stress conditions in the inelastic range, of the deflection of an edge-supported, initially flat membrane under normal pressure. Failure of an idealized elasto-plastic material will not necessarily occur when the yield stress is first reached. The relationships between pressure and deflection and between pressure and strain are illustrated, and both cylindrical and spherical deformations are considered. 19 pp. Illus.

- RM-2182. Costs of procurement deferral with interim contractor support: Hi-Valu airframe spares (U).** W. A. Steger. 5-22-58. Unclassified.

A supplement to RM-2085, *Savings from Procurement Deferral with Interim Contractor Support: The Case of Hi-Valu Airframe Spares*, which summarizes RAND's work to date on the deferred spares procurement concept and analyzes the net worth of procurement deferral by quantifying its gains and costs. The present research memorandum examines not only the cost estimates of spares procurement deferral, but also the possibility of reducing the monetary costs of deferred procurement. This investigation may aid the Air Force in estimating the kinds and magnitude of the costs incurred in any deferred procurement program and may suggest a program for implementing the "buffer stock policy" implied by the deferred procurement system. 60 pp. Illus.

- RM-2183 (AD 156021). A photographic system for close-up lunar exploration.** M. E. Davies. 5-23-58. Unclassified.

A description of a photographic system that may be used to obtain pictures of either the visible or hidden side of the moon from an early space vehicle. Existing components are suitable for the space vehicle. A panoramic-type camera can be designed in which the spin that stabilizes the vehicle also performs the scanning function for the camera. Tracking can be accomplished by radio. The recovery of the film after its return to earth appears feasible. 31 pp. Illus.

- **RM-2185 (AD 156018). Middle East crises and world petroleum movements.** Harold Lubell. 5-26-58. Unclassified.

A discussion of two major interruptions in the supply of oil from the Middle East which have occurred in the present decade, in Iran in 1951 and at Suez in 1956. The resulting oil shortages resolved themselves into shipping crises which were met by reorganization of the tanker facilities of the western international oil companies. This study surveys the effects of these crises on world petroleum production and shipping and examines the impact of a hypothetical future interruption of the flow of Middle Eastern oil to the western world. 51 pp. Illus. See revised version P-1421.

- **RM-2189 (AD 207450). Some applications of dynamic programming to communication and information theory.** R. E. Bellman and R. E. Kalaba. 6-3-58. Unclassified.

A study which shows that the fundamental problem of determining the usefulness of a noisy communication channel in conveying information can be interpreted as a problem within the framework of multistage decision processes of stochastic type. As such, the problem may be treated by means of the functional-equation technique of dynamic programming. Part I of this research memorandum formulates several aspects of the general problem in terms of stochastic multistage decision processes. Part II examines communication processes involving the use of channels, the statistical properties of which are not completely known. 42 pp. Illus. See also P-1223, P-1416, and P-1500.

- **RM-2190-RC. An economic analysis of the market for scientists and engineers.** A. A. Alchian, K. J. Arrow, and W. M. Capron. 6-6-58. Unclassified.

An attempt to determine whether there is now or has been in the recent past a "shortage" of scientists and engineers, and, if so, in what sense a shortage can exist. Reasons for seeking a greater supply of scientists and engineers are discussed, and four possible defects in the economic system that affect demands for scientists and engineers are considered. Arguments about the efficiency of our educational system are evaluated, and a case is made for the policy of differential pay for teachers according to the scarcity of their specialists. 125 pp. Illus.

- **RM-2194 (AD 133047). Some fundamental considerations relating to advanced rocket propulsion systems.** J. H. Huth, B. W. Augenstein, and R. D. Holbrook. 3-11-58. Unclassified.

A discussion, in general terms, of the problems of maximizing specific impulse, acceleration, and burnout velocity for jet-propelled vehicles. Emphasis is placed on the limitations imposed by the prime energy source as velocities become relativistic. Two specific means of obtaining very high jet velocities are examined: ion acceleration by electrostatic fields and acceleration of a current-carrying conductor by a magnetic field. Only constant-thrust vehicles are considered. 43 pp. Illus.

- RM-2200 (AD 156034). Cost and performance data from LP-I: the first experiment in simulation by the Logistics Systems Laboratory.** R. L. Winestone. 7-9-58. Unclassified.

A summary, in terms of cost and effectiveness of performance, of the results of Laboratory Problem I (LP-I), an experiment designed to test a promising set of logistic policies and procedures for the USAF. These policies and procedures were incorporated into an operable laboratory model system designated as Logistics System 2 (LS-2), which was pitted against an analogous model representing the actual policies and procedures of the Air Force as of mid-1956 (LS-1). The framework within which both systems operated was the simulated supply and maintenance activity connected with phasing in and supporting an aircraft employed by the Air Defense Command. 119 pp. Illus.

- **RM-2201 (AD 156037). A proposed method for obtaining ductility in beryllium by the use of a composite arrangement.** W. R. Micks. 5-1-58. Unclassified.

A proposal of a method for obtaining ductile behavior in beryllium by using a laminated-grain composite arrangement. By building into the beryllium the mechanism for plastic deformation, and by exploiting beneficial surface effects to favor ductile behavior over that of brittle fracture, sufficient isotropic ductility may be obtained to make beryllium attractive as a structural material. The author suggests that this idea be investigated, considering the small cost in relation to the large potential benefits. 11 pp. Illus.

- **RM-2202 (AD 156017). The condition of the Soviet economy.** Oleg Hoeffding. 7-1-58. Unclassified.

An analysis of the present state of the Soviet economy to determine what has happened that might warrant a major reappraisal of the present and future economic strength of the Soviet Union. The study warns against mistaking certain recent developments in the Soviet economy (e.g., the abandonment of the Sixth Five Year Plan and the slowdown in industrial growth) for manifestations of critical weaknesses. It suggests that current Soviet economic problems are largely related to Khrushchev's simultaneous pursuit of several major objectives, which all compete for resources and impose a certain strain on the economy. The Soviet economy appears to provide an adequate base for the military and political challenges offered by the USSR. 18 pp. Tables.

- **RM-2205 (AD 156038). A spatial model of U.S. petroleum refining.** T. A. Marschak. 6-30-58. Unclassified.

An addition of spatial dimension to a linear-programming model of U.S. petroleum refining constructed by A. S. Manne. Refining technology in each of four U.S. regions (Gulf, Midwest, East, West) is described by a 39-row matrix obtained from Manne's 105-row matrix by aggregation procedures. Other rows and columns of the spatial-model matrix deal with shipment of commodities between regions by pipeline, tanker, barge, and tank-car and with transport within each region. The final spatial model has 195 rows, 1555 columns. One computational result has been obtained, that of maximum amounts of the 1952-53 mix of regionally located end-items for successively lower availabilities of tankers. 125 pp. Illus.

- **RM-2206-RC (AD 226412). Some specific suggestions for achieving early non-military defense capabilities and initiating long-range programs.** Herman Kahn. 1-2-58. Rev. 7-1-58. Unclassified.

Part of a broader investigation concerned with measures that should be taken in the non-military defense of the United States. The study proposes that the government initiate a program costing around \$500 million to achieve several objectives dealing with non-military defense, and measures to achieve these objectives are suggested. 116 pp. Tables.

- **RM-2207 (AD 211940). Government acquisition of agricultural output in Mainland China, 1953-56.** Ronald Hsia. 9-3-58. Unclassified.

An estimate of government acquisitions of agricultural products in Mainland China from 1953 through 1956, based on data from tax collections and government purchases. After allowing for relief payments in kind and government sales to the agricultural sector, net government acquisitions are found to have risen from 9.6 billion yuan in 1953 to 12.4 billion yuan in 1955. They declined to 10.4 billion yuan in 1956. 102 pp. Tables.

- **RM-2208 (AD 156016). Aerodynamic characteristics and geometric properties of half- and complete-ring-body configurations for supersonic design Mach number.** R. P. Johnson. 7-9-58. Unclassified.

A presentation of the optimum aerodynamic characteristics and the associated nondimensional geometries for half- and complete-ring-body configuration as functions of three parameters: design point Mach number, reduced aspect ratio of the wing planview, and average skin friction coefficient. These configurations use thickness drag cancellation, skin friction reductions, and drag-due-to-lift reductions to effect high lift-drag ratios. 68 pp. Illus.

- **RM-2209 (AD 156047). Notes on linear programming—part XLVII: solving linear programs in integers.** G. B. Dantzig. 7-11-58. Unclassified.

The development of a variant to a recent result of Gomory (Princeton). In solving linear programs in integers, Gomory showed how to add linear inequality constraints to a linear-programming problem automatically in such a way that the extreme points of the resulting convex contain only integral solutions in the neighborhood of the minimum. The present study gives an alternative method for generating additional constraints in a way easy to justify and apply. It is not known, however, whether these conditions will lead to a solution in a finite number of iterations as is true for the stronger Gomory conditions. Anyone considering their practical use should therefore weigh the ease of generation against the extra number of iterations required for convergence. 12 pp. A revision of P-1359.

RM-2211 (AD 156025). Reflection factors for normally reflected shocks in air. H. L. Brode. 7-14-58. Unclassified.

A derivation of the shock reflection values for the special case of normal reflection. In the higher pressure regions of interest, the reflection of shocks cannot be treated with the ideal polytropic gas formulas since the equation of state for air indicates considerable variance. 11 pp. Illus.

- **RM-2213 (AD 156019). The Soviet role in international civil aviation.** Hans Heymann, Jr. 12-4-57. Unclassified.

A discussion of the vast Soviet program of global air-transport expansion that is designed to undermine our own aviation leadership. Two aspects are examined: (1) from the viewpoint of aviation equipment, what do the recent development trends in the USSR tell us about the Soviet ability to compete technologically or economically in this field? and (2) from the viewpoint of international air routes, how serious are their ambitions, and how promising are their opportunities for developing a global air-transport network? 22 pp. Illus.

- **RM-2218 (AD 156026). The anatomy of deterrence.** Bernard Brodie. 7-23-58. Unclassified.

Another in a series of studies concerned with the general theory of air strategy in a nuclear age. The present study deals with some of the peculiar and historically novel requirements of a deterrence posture. The argument presented is that modern deterrence is like traditional deterrence in some respects, but differs in that today deterrence of total war is considered a policy that must go permanently unchallenged. A deterrence strategy diverges significantly from a strategy which emphasizes ability to win if war comes. 35 pp. Also published as P-1405. Incorporated in R-335. Also incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, New Jersey, 1959. \$6.50.

RM-2220 (AD 206441). Implementing logistics policies in Laboratory Problem I (LP-I). A. J. Clark and R. M. Paulson. 6-25-58. Unclassified.

A description of two provisioning and inventory management policies developed by RAND's Logistics Department and tested in Laboratory Problem I (LP-I). These policies were incorporated into an operable model system designated as Logistics System 2 (LS-2) and were pitted against an analogous model, Logistics System 1 (LS-1), representing then-current Air Force procedures. The two models were run simultaneously for a period representing 14 quarters of real-world operation. The framework of this operation consisted of the simulated supply and maintenance activity connected with phasing in and supporting an aircraft used by the Air Defense Command. 95 pp. Illus. See also R-323.

- **RM-2222 (AD 205421). Proposed non-stoichiometric ceramics.** W. J. Knapp. 7-28-58. Unclassified.

A proposal for developing a ceramic that possesses ductility. A non-stoichiometric ceramic is suggested for development. It is defined as a parent stoichiometric compound, the crystal lattice of which accommodates an excess of metal ions, resulting in a single-phase material. The anticipated crystal structure and mechanical properties of non-stoichiometric ceramics are described. 13 pp. Illus.

- **RM-2223-AEC (AD 214846). The free-free Gaunt factor in an ionized medium.** J. M. Green. 7-29-58. Unclassified.

A study of the free-free radiative scatterings of electrons in the Debye screened potential. Three different approximate solutions are shown, with different solutions, in general, covering different regions of validity. For the case of greatest physical interest, that of "small screening," the screened Gaunt factor is very simply related to the unscreened Gaunt factor. In particular, a simple criterion is obtained to measure the importance of screening in free-free scattering. 66 pp. Tables.

- **RM-2224 (AD 156027). The meaning of limited war.** Bernard Brodie. 7-30-58. Unclassified.

Part of a broader investigation concerned with the general theory of air strategy in a nuclear age. The present memorandum analyzes the nature of limited war as conceived of today, and contrasts it with limited war as experienced in the past. Limited war in the past meant limited effort, while for the present and future it must mean restraint on an already mobilized and tre-

mendously powerful force and deliberate resort to less efficient measures. However, it is dangerous to assume that total war has been abolished. 27 pp. Also published as P-1222. Incorporated in R-335. Also incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, N.J., 1959. \$6.50.

- **RM-2225 (AD 210222). Two methods of obtaining earth satellite positions from simple photographic observations.** W. K. Squires. 2-12-58. Unclassified.

Two methods of determining the position of an earth satellite from simple photographic observations. One method requires two stations that obtain simultaneous photographs. The second method involves a single station using accurate timing. Computational techniques are described, an analysis of errors is made, and sample computations for actual Sputnik transits are given. 70 pp. Illus.

- RM-2232. A data-processing concept for Air Force bases.** J. A. Postley and S. L. Pollack. 9-5-58. Unclassified.

A description of the characteristics of an optimum system for base data processing, and a formulation of these desired characteristics into a specific plan that can be partially implemented by 1962. To cope with the increasing dispersal of operating units and the growing complexity of scientific management techniques, the major portion of data processing for the Air Force base complex in the continental United States should be performed at several central organizations remote from the bases themselves, and the effort to introduce semiautomatic or automatic techniques for data introduction should be increased. When a sound basis for decision is provided, the scientific management and data-processing-equipment tools can be used effectively. 78 pp. Illus. See also RM-1417, RM-1639-1, RM-2013, and RM-2269.

- RM-2233 (AD 210498). Experimental design, test, and evaluation of an F-100D flyaway kit.** Bernard Okun. 10-31-58. Unclassified.

One of a series of studies dealing with the flyaway kit problem. The present memorandum describes and analyzes the results of an F-100D flyaway kit test, designed to compare the effectiveness of six alternative "paper" flyaway kits and to evaluate the merits of the RAND flyaway kit method. Consumption data were collected for a 30-day period from two F-100D squadrons stationed in West Germany, and were then compared with the contents of each kit. A kit's effectiveness was measured in terms of its ability to satisfy the squadrons' demands for spare parts. 107 pp. Illus. See revision P-1725. See also RM-1490 and RM-2062.

- RM-2235 (AD 156033). Design-change history of F-100 Hi-Valu airframe spare parts.** Sadako Hayase. 8-15-58. Unclassified.

An examination of the design-change pattern in the Hi-Valu airframe spare parts of the F-100 aircraft series and of how these design changes influence line-item effectivity and applicability. The study considers background events in production and model development within which F-100 design changes have occurred, the relation of line item and functional-group growth resulting from design change, and the temporal aspects of production use and the applicability of design change in terms of delivered aircraft. This investigation may aid in developing supply-support programs for reducing design-change problems. 80 pp. Illus.

- **RM-2240 (AD 156050). Complements and substitutes in the optimal assignment problem.** L. S. Shapley. 8-22-58. Unclassified.

A study of the "optimal assignment problem" as a process that depends intricately on several input activities. The complementarity-substitutability relationships between its elements are established—i.e., whether the relationships reinforce or interfere with each other's influence on the process as a whole. It is shown that in a standard interpretation of the problem, man-machine pairs are complementary while man-man and machine-machine pairs are substitutes. 13 pp. Illus. See updated version P-2184.

- **RM-2244 (AD 230074). Heat transfer in a dissociating gas.** P. H. Greifinger. 8-28-58. Unclassified.

An evaluation of the effects of finite reaction kinetics on heat transfer. The model considered is a chemically reacting gas confined between two plates maintained at different temperatures. The specific type of chemical reaction investigated is the dissociation-recombination reaction $X_2 \rightleftharpoons 2X$. Heat transfer is found to be sensitive to the values of G^2 (proportional to the ratio of the volume

reaction rate to the diffusion rate) and β (proportional to the ratio of cold-wall efficiency in causing atom recombination to the particle mean free path between the plates divided by the separation of the plates), provided that neither parameter is too large. The heat transfer approaches its equilibrium value for either $G^2 \rightarrow \infty$ or $\beta \rightarrow \infty$. 47 pp. Illus.

- **RM-2245 (AD 206553). On the computational solution of dynamic-programming processes—XVI: reliability of multicomponent devices.** R. E. Bellman and S. E. Dreyfus. 9-2-58. Unclassified.

A proof that the functional-equation technique of dynamic programming may be used to treat a class of problems that arise in the construction of multicomponent devices. An attempt is made to determine the types of components and the quantities that should be used for constructing the most reliable device possible subject to given cost and weight constraints. A numerical example is given. 19 pp. Illus. A revision of P-1139.

- **RM-2259 (AD 211941). On the growth of duty cycle in intermittent communication systems.** Edward Bedrosian. 9-23-58. Unclassified.

A review of the mechanism of meteor-burst propagation, and a discussion of the operating principles of typical systems. A model of burst occurrence and duration is constructed. Total burst time and duty cycle are computed, for given intervals of time, as randomly distributed quantities. 36 pp. Illus.

- **RM-2260 (AD 207751). Theoretical development for lifting ring-body configurations.** R. P. Johnson. 9-9-58. Unclassified.

A presentation of the theoretical development of a concept of aerodynamic design employing ring-body configurations. It is shown that great improvement in lift-drag ratio may be obtained for these configurations through (1) cancellation of the body thickness drag with a concentric ring wing, (2) minimization of both wave-drag and vortex-drag contributions to lifting drag, and (3) reduction of viscous drag through a parametric reduction of skin friction coefficient. The concept is developed to a point from which geometry and performance parameters can be computed. 76 pp. Illus.

- **RM-2263 (AD 206554). On the linear relation between the softening temperature and the melting point of ceramics.** G. A. Hoffman and W. J. Knapp. 10-1-58. Unclassified.

An investigation of the linear relation between the softening temperature and melting point of ceramics. Some linear relation is apparent, enabling prediction of the upper temperature limitations of untested ceramics. 15 pp. Illus. Also published as P-1606.

- **RM-2264 (AD 209777). Preliminary analysis of a satellite recovery system.** R. H. Frick. 9-19-58. Unclassified.

An analysis of the capabilities of a recoverable satellite system. The study considers the problem of determining the magnitude and direction of a velocity impulse required to return a satellite at a specified spot on the earth. The dispersion in range and deflection about the desired impact point is evaluated in terms of the capabilities of the vehicle propulsion and attitude control system, as well as of the satellite tracking system. In addition, a velocity diagram is developed which provides a convenient tool for determining the subsequent characteristics of a trajectory as a function of the velocity and path direction corresponding to a given initial position. 56 pp. Illus.

- **RM-2265 (AD 209536). A class of function-space games.** O. A. Gross. 10-8-58. Unclassified.

A solution to two classes of two-person zero-sum games over function space, arising from a mine-laying and search problem. Any game in either class shares, with all other games in the two classes, a common pure optimal strategy for the maximizer. The games of the first class have saddle points in pure strategies of special character. The second class consists of subgames of the first, obtained by restricting the minimizer's strategies to characteristic functions. In general, these games require mixed strategies for the minimizer, and the value of a game of the first class is strictly less than the value of its subgame in the second class. 11 pp.

RM-2269. The next step in Air Force centralization of inventory recordkeeping and supply data processing. Leon Gainen. 10-16-58. Unclassified.

An attempt to indicate the gains in operational effectiveness possible with centralized recordkeeping of weapon system base and weapon system storage site accounts. A method is outlined for controlling the inventory in a weapon support system by means of centralized electronic data processing at a Data Processing Center (DPC). Under this system the Logistics Support Manager (LSM) keeps the records for all materiel, at bases and storage sites, in support of the weapon system. Data prepared under the proposed system will be available as rapidly as they are now, will be more accurate than those produced by present base processing equipment, and can be presented in a more comprehensive form specifically designed for management decisionmaking. 63 pp. Illus. See also RM-1417, RM-1639-1, RM-2013, and RM-2232.

● **RM-2270 (AD 205871). The response of hypothetical missile transport equipment to nuclear blast.** W. R. Elswick. 10-16-58. Unclassified.

An attempt to analyze the loading and response of a structure when it is subjected to overturning by the blast of an atomic explosion, and to present some results for mobile equipment which may be typical of mobile ballistic missile equipment. The study assumes that the structure is rigid and free to rotate about the fixed downwind wheel line, that the drag coefficient and drag area are constant, and that the diffraction load rises abruptly with the arrival of the shock front and decays linearly to zero in the time required for the shock front to traverse a distance equal to one and one-half times the vehicle height. 18 pp. Illus. See also RM-2410.

● **RM-2271 (AD 156049). Correlation energy of a degenerate electron gas.** R. A. Ferrell. 9-5-58. Unclassified.

A proof (1) that the equation for the potential correlation energy of a degenerate electron gas in terms of the total energy provided by the virial theorem is identical to that obtained by differentiating the ground-state energy eigenvalue in connection with the electrostatic coupling constant, (2) that the second derivative of the correlation energy in connection with the coupling constant can never be negative, (3) that the asymptotic behavior of the zero-point energy is not properly represented by Wigner's interpolation formula, and (4) that all correlation calculations can, with minor modifications, be applied to the ferromagnetic state of the electron gas. 23 pp. Illus. Also published as P-1523.

✕ **RM-2272-AEC (AD 205872). Relativistic self-consistent calculation for the normal mercury atom.** Stanley Cohen. 7-28-58. Unclassified.

A presentation of the relativistic self-consistent solutions of the Hartree type for the normal mercury atom. The single-particle wave functions making up the atomic wave function are assumed to be solutions to the relativistic Dirac equation. The study describes the technique and numerical methods used to obtain these results. The eigenvalues obtained with both the results of the previous nonrelativistic calculation and with the experimental-term values are compared. It is shown that appreciable corrections to the eigenvalues are made by including the relativistic effects. 71 pp. Table. See also RM-2404-AEC-RM-2406-AEC.

● **RM-2273 (AD 209537). A problem in spectrum estimation.** Peter Swerling. 8-8-58. Unclassified.

A method of analyzing the structure of a frequency spectrum, based on the observation of some portion of a sample function. In application, the method might be used to yield information on the velocity of a space vehicle. 28 pp. Illus. See revised version P-1788.

● **RM-2275 (AD 207200). Recent results of high-altitude research by means of rockets and satellites.** H. K. Kallmann. 8-28-58. Unclassified.

An account of the more important recent advances in high-altitude research based on rocket and satellite data and a presentation of a quantitative picture of our current knowledge of atmospheric physics. Some findings which have not yet been properly integrated into our new picture of the atmosphere are included. 34 pp. Illus.

RM-2276 (AD 209422). Minimal impulse requirements for disorbiting satellites.

I. S. Blumenthal, 10-15-58. Unclassified.

A study of the minimal velocity impulse which must be imparted to satellites on circular and elliptical orbits to "knock them out of orbit" and cause them to impact the earth. It is concluded that the idea of "shooting down an unfriendly satellite" may not be as ridiculous as supposed and that the development of proper techniques will afford us a desirable form of defensive counter-action. 36 pp. Illus.

- **RM-2277 (AD 225891). A handbook for estimating material requirements and costs of shelter doors subjected to long-duration blast loading.** C. A. Sandoval. 10-24-58. Unclassified.

Data used to estimate both the quantities of materials and the costs for various sizes of shelter doors made of reinforced concrete, solid-steel slab, and wide-flange steel beams. Results are presented for overpressures up to 400 psi. Resistance to nuclear and thermal radiation is not considered. It is shown that wide-flange structural shapes are the lightest, reinforced concrete slabs are the most economical, and solid-steel slabs are the most expensive. For small spans, steel slabs are suitable, since they require little fabrication. 45 pp. Illus.

- **RM-2279 (AD 209022). An optimal-inventory model.** O. A. Gross. 10-24-58. Unclassified.

An attempt to determine what inventory-ordering policy maintains the inventory as low as possible at all times. A situation is considered where there is an empty inventory of two different items and where a buyer has the option at any time of ordering either of two specified kinds of packages—of different composition of the two items but of equal total amount—subject to the constraint that no item is allowed to be depleted for a positive length of time. The second part of this study discusses a proposed solution to a problem involving discrete replenishment, by tankers of specified type, of several kinds of continuously depleting petroleum products at three different port facilities. 25 pp. Illus.

- **RM-2280 (AD 225892). A correlation of the critical conditions for homogeneous bare reactors.** B. Pinkel and G. B. W. Young. 10-29-58. Unclassified.

A method for correlating, over a wide range of moderator-to-uranium ratios, the critical conditions for homogeneous bare reactors having various types of moderators. The method is applied to the results of an eighteen-group analysis of homogeneous bare reactors and to some experimental results, and good correlation is obtained. This correlation shows the effect of the nuclear properties of the reactor materials on the criticality conditions, and permits these conditions to be estimated for other bare reactors. 57 pp. Illus.

- **RM-2282 (AD 232873). On the computational solution of dynamic-programming processes—XIV: missile-allocation problems.** R. E. Bellman, S. E. Dreyfus, O. A. Gross, and S. M. Johnson. 11-13-59. Unclassified.

One of a series of studies that applies dynamic-programming techniques to the computational solution of mathematical problems involving multistage decision processes. This memorandum applies the dynamic-programming technique to problems involving the optimal allocation of attack against a target system and the optimal allocation of defense against this attack. In the case of two types of attackers (either manned aircraft and decoys, or missiles of different capabilities), the Lagrange-multiplier technique is applied to reduce the computational solution to one involving sequences of functions of one variable. Large-scale target allocations are resolved computationally in a reasonable period of time with the use of such computers as the RAND JOHNNIAC or the IBM 704. 40 pp. Illus.

- **RM-2285-RC. Some attributes of the changing society.** J. D. Williams. 11-10-58. Unclassified.

Part of a broader investigation concerned with the place of mathematics in the changing society, prepared in response to an invitation from the National Council of Teachers of Mathematics. The memorandum surveys and discusses certain striking features of our times, external and internal to our society, such as the rate of change of technology and population growth. The fact is emphasized that we have a lot of thinking to do and not much time to do it and that it would be wise to make decisions and choices deliberately while there are real alternatives, rather than by default when there are none. 18 pp.

- **RM-2286 (AD 207752).** A preliminary model atmosphere based on rocket and satellite data. H. K. Kallmann and M. L. Juncosa. 10-30-58. Unclassified.

A presentation of a preliminary model atmosphere for an altitude region between 100 and 800 km. The scientific results obtained from rockets as well as from satellites are used to determine the variation of density with altitude. The pressure and scale height are calculated from the density. The experimental and theoretical results are shown in the form of graphs and tables. Because of solar effects these physical parameters may vary by a factor of two or more, which is approximately the average uncertainty involved in evaluating the experimental data. 52 pp. Illus. See revised version P-1591.

- **RM-2287 (AD 208311).** Notes on linear programming—part XLVIII: inequalities for stochastic linear programming problems. Albert Madansky. 11-13-58. Unclassified.

A consideration of a linear-programming problem in which the "right-hand side" is a random vector whose expected value is known and where the expected value of the objective function is minimized. The conditions are studied under which an approximate solution (found by replacing the "right-hand side" by its expected value and solving the resulting linear programming problem) is satisfactory. In particular, conditions are given for the equality of the expected value of the objective function for the optimal solution and the value of the objective function for the approximate solution. Bounds on these values are also given. The relation is discussed between this problem and a related problem where an observation is made on the "right-hand side" and where the non-stochastic linear programming problem based on this observation is solved. 19 pp. Also published as P-1600.

- **RM-2288 (AD 211149).** Invariant imbedding and wave propagation in stochastic media. R. E. Bellman and R. E. Kalaba. 11-17-58. Unclassified.

An application of the theory of invariant imbedding to problems of propagation in stochastic media. The particular example is discussed in which a plane wave is incident on a stratified slab which is characterized by stochastic wave numbers in each stratum. The distribution functions for the amplitude of the random reflected and transmitted waves can then be determined by Monte Carlo, or analytically under very special assumptions. The study illustrates the applicability of functional equations and principles of invariance to the study of various types of wave propagation; indicates the importance of functional equations in stochastic variables prior to the appearance of any expected values; and emphasizes that to determine the nonlinear aspects of the recurrence relations, the actual probability distribution of the random variables appearing must be examined. 28 pp. Illus.

- **RM-2290 (AD 210003).** The Soviet Union and the atom: peaceful sharing, 1954-1958. A. M. Jonas. 11-20-58. Unclassified.

A study concerned with the peaceful sharing of atomic energy from 1954 to 1958 by the USSR with certain nations in the Soviet bloc. Factors motivating the initiation of such a program are discussed, and the nations receiving this assistance are listed. Aware of a "fourth country" problem, the Soviet Union is slowly implementing the initial sharing offers with its satellites and is keeping this activity outside the Soviet Union to a level that can be controlled by Moscow. However, considering that none of the orbit nations had an atomic program before 1955, the achievement to date is impressive. Sharing outside the orbit is chiefly a useful supplementary device by which to attain certain established international objectives. It is assumed that the Soviet leaders will keep the program limited so that the resources needed for the expansion of peaceful atomic applications in the USSR will not be drained. 158 pp. See shortened version P-1741.

- **RM-2292.** Thermodynamic properties of carbon dioxide to 24,000°K with possible application to the atmosphere of Venus. J. L. Raymond. 11-26-58. Unclassified.

A study of the properties of 100 per cent CO₂ (carbon dioxide) in the temperature range of 1000°K to 24,000°K and pressure range of 10⁻⁴ to 10² atmospheres. The properties calculated are enthalpy, entropy, molecular weight, density, internal energy, and molar composition. A Mollier chart for 100 per cent CO₂ in these ranges is presented. This study is of interest to those concerned with aerodynamic problems of entry into the Venusian atmosphere, about 90 per cent of which, by weight, consists of carbon dioxide. 64 pp. Illus. See abridgment P-2218-1.

- **RM-2297 (AD 209538). A dynamic, single-item, multi-echelon inventory model.** A. J. Clark. 12-8-58. Unclassified.

A mathematical model constructed as a computational aid for planners attempting to establish least-cost order and supply policies within a complex and dynamic structure. The model is a dynamic, single-item, multi-echelon inventory model, which integrates stockage policies for individual activities to minimize inventory costs for the logistics system as a whole. A typical Air Force supply system is used as its frame of reference, in which many bases stock a particular item, a depot replenishes base stocks, and a factory and a repair facility resupply the depot with new and repaired items. The main decisions to be made at any given time are how much to ship to each base, how much to repair, and how much to procure from the factory. The dynamic element in the problem is accentuated by bases phasing into and out of operation at different times and experiencing changing failure patterns while in operation. 43 pp. Illus.

- **RM-2300-RC. The rocket performance computer.** E. H. Sharkey. 12-8-58. Unclassified.

An instruction book describing the operation of the Rocket Performance Computer. Enclosed with the publication, the computer aids in calculating rapidly approximate solutions to single-stage rocket performance problems. By iterative solutions, multistage performance can also be calculated. 18 pp. Illus.

- **RM-2304 (AD 215771). Bibliography of literature on optimum design of structures and related topics.** W. R. Micks. 12-15-58. Unclassified.

The title of this research memorandum describes its contents. 52 pp.

- **RM-2305 (AD 210497). Terms of trade between the Soviet Union and smaller communist countries, 1955 to 1957.** Horst Mendershausen. 1-18-59. Unclassified.

An attempt to determine whether the smaller communist countries suffer price disadvantages in trading with the Soviet Union. Soviet foreign trade data show evidence of price discrimination at the expense of the smaller communist countries in Europe from 1955 to 1957. These countries apparently were not paid particularly well for their goods to make up for the high charges for Soviet exports. Soviet export terms to the satellites were generally less favorable than British import prices and were also less responsive to changes in the latter than were Soviet terms to Free Europe. The limitation of the bargaining freedom of the smaller communist countries is attributed to their peculiar relationship with the USSR, which is in a monopolistic-monopsonistic position. 64 pp. Illus. See extension RM-2507-1-PR. Also published as P-1598.

- **RM-2313 (AD 215301). A new analytic representation of surface interaction for hyperthermal free-molecule flow with application to neutral-particle drag estimates of satellites.** Richard Schamberg. 1-8-59. Unclassified.

A re-examination of the customary analytic representation of the gross effects of the interaction between individual gas molecules in a free field and the solid surface of the body passing through the field. An alternative model for surface interaction is proposed and is used to calculate force coefficients of flat plate and convex bodies in "hyperthermal" free-molecule flow. Derived formulae are used to estimate the effects of uncertainty in the surface interaction on the drag of satellites. 93 pp. Illus.

- **RM-2314 (AD 219799). Damage to X-ray detectors by meteorites.** A. A. Broyles. 1-21-59. Unclassified.

An estimate of the effect of meteorites on a beryllium window covering an X-ray detector on a satellite with the aid of the latest meteor density information from astronomical and satellite measurements. Bjork's formula for the depth of penetration of high-velocity particles striking a surface is used to obtain an estimate that only one-millionth of the area of the window would be punched out by meteorites per year. Methods for reducing the amount of sunlight leaking through the holes to the photomultiplier tube are considered. Splitting the beryllium sheet into two parts appears advantageous for reducing the effect of window damage from meteorites. 28 pp. Illus.

- **RM-2317 (AD 233143). On one-dimensional neutron multiplication.** T. E. Harris. 1-18-60. Unclassified.

A discussion of a model (related to one used earlier in RM-2288, *Invariant Imbedding and Wave Propagation in Stochastic Media*) to investigate the probability distribution of the total number of neutrons produced by an initial trigger neutron. Emphasis is given to the case in which the length of the fissionable body is exactly critical. The model is a simplified one that examines only one-dimensional motion of the neutrons in a nuclear chain reaction. The results of this work may be suggestive to nuclear physicists and weapon designers in studies of critical size or of situations in which a stray neutron may excite a chain reaction. 33 pp. See also RM-2693.

- RM-2318 (AD 213259). A note on the numerical integration of nonlinear partial differential equations.** R. E. Bellman, I. Cherry, and G. M. Wing. 1-26-59. Unclassified.

A description of a new method for the numerical integration of a class of nonlinear hyperbolic partial differential equations that admit discontinuities of the type occurring in the study of shock-wave phenomena. The equation $u_t = -uu_x$ is discussed, and numerical results are given. 8 pp. Table. Also published as P-1067.

- **RM-2319 (AD 211942). On the computational solution of dynamic programming processes—XI: a feedback-control problem.** R. E. Bellman and S. E. Dreyfus. 1-26-59. Unclassified.

A computational solution, by means of sequences of functions of one variable, to a problem typical of those arising in the design of feedback-control circuits. The usual functional-equation technique of dynamic programming is shown to lead to a computation involving sequences of functions of two variables. The specific problem considered is that of determining the function $v(t)$ to minimize the functional $J(v) = |u(T)| + \lambda \int_0^T v^2 dt$, where $u'' + au' + bu = v(t)$, $u(0) = c_1$, $u'(0) = c_2$, and $m \leq v(t) \leq m'$. Some numerical results are given. 13 pp. Illus.

- **RM-2320 (AD 225228). A mechanical proof of the min-max theorem.** O. A. Gross. 1-26-59. Unclassified.

A description of a machine that solves finite games. The study considers the components of the device to obtain a novel mechanical "proof" of the min-max theorem for finite games based on the laws of statics. 19 pp. Illus.

- RM-2321 (AD 212974). On a linear-programming-combinatorial approach to the traveling-salesman problem: notes on linear programming and extensions—part 49.** G. B. Dantzig, D. R. Fulkerson, and S. M. Johnson. 1-26-59. Unclassified.

A demonstration that the linear-programming-combinatorial approach, wherein simplex multipliers are used in a combinatorial analysis of undominated tours at some stage of the linear-programming approach, affords a practical way of solving traveling-salesman problems. 26 pp. Illus. A revised version of P-1281.

- RM-2322 (AD 215561). Evaluation of the effect of environment on refueling operations.** J. D. Sartor. 1-27-59. Unclassified.

An investigation of the SAC refueling operation in terms of the probabilistic expectation of environmental conditions at an early planning stage. The study, undertaken to determine the degradation of the SAC refueling operation caused by adverse weather, provides the military planner with the means of quantitatively evaluating the factors, including the environment, that influence an operation, allowing him to trade off one against the other to the advantage of the operation as a whole. 34 pp. Illus. See also RM-2080 and P-1895.

- ◊ ● **RM-2323 (AD 256871). A generalized formulation for inertial navigators and gravitationally stabilized satellites.** G. Gordon and M. C. Smith. 3-10-61. Unclassified.

A derivation of three-dimensional error equations for a locally vertical inertial navigation system based on the three-gimbal and five-gimbal concepts. The error equations are presented for undamped

and damped systems. The resulting analytical expressions give the inertial navigators' position and azimuth in terms of the sensing instrument performance. These same equations can be used in analyzing the rotational motion of a gravitationally stabilized satellite. The equations of motion reveal a driving function proportional to the orbit eccentricity. 94 pp. Illus.

- **RM-2326 (AD 211642). Soviet statistics of meat and milk output: a note on their comparability over time.** A. E. Nimitz. 2-6-59. Unclassified.

A review of evidence indicating that data recently published by the USSR on statistics of meat and milk output have a broader coverage than prewar data. Items newly included are estimated to account for approximately 15 per cent of the outputs of meat and milk in 1956. 37 pp. Tables.

- **RM-2327 (AD 215161). Military supersonic transports.** T. F. Cartaino, D. M. Eise-
mann, and R. Schamberg. 2-4-59. Unclassified.

A look at past predictions and future technological possibilities of supersonic transports. Subsonic and supersonic transports, which could be operational in 1970, are costed within the context of typical military missions. The relative cost of supersonic transports and their operational advantages and disadvantages are considered. A decision to spend military research and development funds on a super-sonic transport is shown to be in reality a decision based on an evaluation of the relative importance of conflicting extraeconomic factors. 55 pp. Illus.

- **RM-2328 (AD 237089). Additional values for the equilibrium composition and thermodynamic properties of air.** F. R. Gilmore. 12-30-59. Unclassified.

A supplement to RM-1543, *Equilibrium Composition and Thermodynamic Properties of Air to 24,000°K*, which reports results for the composition, pressure, energy, and entropy of dry air at eleven temperatures between 1000° and 24,000°K and at eight densities between 10^{-6} and 10 times normal density. This research memorandum presents the values of the equilibrium composition and thermodynamic properties of air at two additional temperatures, 10,000° and 50,000°K. The pure ideal-gas properties needed for these tabulations are included. Equilibrium values for the principal charged particles at 1000° and 2000°K and for the CN molecule between 1000° and 8000°K are also listed. Finally, the thermodynamic properties of air between 1000° and 10,000°K at high densities (10 to 316 times standard density) are computed, using approximate corrections for the inter-molecular interactions. 22 pp. Tables.

- **RM-2329 (AD 220064). First-order error propagation in a stagewise smoothing procedure for satellite observations.** Peter Swerling. 6-15-59. Unclassified.

A method of smoothing observational data (using variations of the classical method of minimizing a quadratic form in the residuals) in cases in which observations are determined by the time of observation plus a finite number of parameters, called elements. The object of this stagewise procedure is to estimate the elements. The first-order dependence of errors in estimates on the observation errors is established. Applications to estimation of earth-satellite orbits are discussed. 35 pp. Also published as P-1674.

- **RM-2332 (AD 230073). Estimated damage to space vehicles by meteoroids.** R. L. Bjork and C. Gazley, Jr. 2-20-59. Unclassified.

Some calculations that will have a bearing on the design of vehicle skins and on the expected performance of lenses and other satellite instrument surfaces. Available estimates of the mass and frequency of meteoroids in space are combined with a new penetration theory to yield a range of estimates of skin-penetration probability. The average time before a surface of 1 meter square in area and 1 millimeter in thickness will be punctured ranges between 7 weeks and 620 years. The effects of particle impacts, resulting in erosion of the surface or "sandblasting," are expected to destroy the optical properties of a surface after about a year. 30 pp. Illus.

- **RM-2338 (AD 214635). On network flow functions: notes on linear programming and extensions—part 50.** L. S. Shapley. 3-16-59. Unclassified.

An investigation of the capacity of a network as a function of the capacities of its individual arcs. The case of two variable arcs is examined. It is found that in each pair of arcs they either consistently help each other or consistently hinder each other. Interaction types are computed for a number of special cases. 26 pp. Illus. Also published as P-2185.

- **RM-2341 (AD 215772). Nickel, columbium, molybdenum, and tungsten: a preliminary structural comparison.** G. A. Hoffman. 3-18-59. Unclassified.

An illustration of how certain optimum design methods may be used to compare nickel, columbium, molybdenum, and tungsten in applications to structures that are designed by buckling criteria or by simple uniaxial tension. The study, based on stress-strain data assumed to represent the best alloys currently available, shows nickel to be superior up to 1300°F and tungsten to be superior beyond 2000°F. 29 pp. Illus.

- RM-2348 (AD 231242). Lift of slender nose shapes according to Newtonian theory.** J. D. Cole. 2-4-58. Unclassified.

An extension of a method for predicting pressure forces and computing flow fields for slender bodies of revolution at zero incidence to the case of flow past bodies at an angle of attack. 24 pp. Illus. Also published as P-1270.

- **RM-2349 (AD 214945). Summary and recommendations regarding underground phenomenology.** H. L. Brode. 3-27-59. Unclassified.

Conclusions (reached by a relatively small group meeting in conjunction with the Second Symposium on Protective Construction held at RAND, March 24-27, 1959) on the present status and the probable future of research into the underground phenomena associated with air- or surface-burst nuclear explosions. While emphasis in the main symposium was on construction techniques and practical problems, this small working group was principally concerned with the physical phenomena related to the survival or failure of deep underground structures. The range of pertinent phenomena discussed extended from the earliest phases of cratering through the propagation of various waves and included the interaction of these waves with underground structures. 30 pp. Illus.

- **RM-2354 (AD 219515). On the application of dynamic programming to a class of implicit variational problems.** R. E. Bellman and J. M. Richardson. 4-6-59. Unclassified.

An illustration of the applicability of the functional-equation technique of dynamic programming to the computational solution of implicit variational problems. Questions of this type arise in connection with the problem of landing a rocket on the moon, or on another planet, with minimum terminal velocity, and in connection with problems involving minimum miss-distance. 18 pp. Also published as P-1374.

- RM-2365. Supply and depot-repair interactions: a case study of electronics support.** J. W. Petersen, R. M. Paulson, and W. A. Steger. 4-16-59. Unclassified.

A study concerned with a segment of the electronics-support cycle in Air Force logistics. An attempt is made to analyze the nature of the response-supply tradeoff for the depot-repair cycle to determine the proper mix of depot-maintenance effort and supply stocks and to achieve the most economical joint cost for a given level of support efficiency. The depot-repair cycle is defined as the time interval between the start of physical repair action and the shipping of the repaired item back into the supply system. While the analysis is limited to fire-control-support experience, the nature of the tradeoff studied applies to any depot-reparable item. The study demonstrates the importance of including the supply-cost implications of repair-cycle length as an explicit element in planning repair capability and as a criterion of depot performance. 61 pp. Illus. See also RM-2418.

- **RM-2367-AEC. Graphs of X-ray absorption coefficients for fourteen substances.** F. R. Gilmore. 4-10-59. Unclassified.

A collection of experimental and theoretical values for the X-ray absorption coefficients of beryllium, carbon, nitrogen, oxygen, aluminum, iron, copper, silver, tin, gold, lead, uranium, air, and sodium iodide, in the energy range from 0.1 to 100 kilovolts. 21 pp. Illus.

- **RM-2368. A note on polynomial and separable games.** D. Gale and O. A. Gross. 7-20-60. Unclassified.

Part of RAND's continuing work on the theory of games. It is shown that, given a pair of infinite metric spaces and a pair of respective finite mixed strategies, there exists a separable game with bounded continuous payoff on the cartesian product such that the given strategies constitute the

unique solution of the game. An analogous result holds for polynomial games. 16 pp. Also published as P-1216. Incorporated in *The Theory of Linear Economic Models* by David Gale, McGraw-Hill Book Company, Inc., New York, 1960. \$9.50.

Ø RM-2372-AEC (AD 218924). **Relativistic self-consistent calculation for the normal uranium atom.** Stanley Cohen. 2-10-59. Unclassified.

A presentation of the relativistic self-consistent solution for the normal uranium atom. A comparison is made between the energy eigenvalues for each of the subshells with corresponding experimentally determined energy-term values. 64 pp. Tables. See also RM-2272-AEC.

RM-2374 (AD 220605). **The base maintenance-operations model used in RAND logistics research.** R. A. Levine and R. B. Rainey. 5-4-59. Unclassified.

A description of the model that RAND's Logistics Department uses in studying the interaction of aircraft operations and base-level logistics, particularly direct maintenance. This model (1) improves on past methods of estimating the effects of Air Force maintenance and operations policies, (2) simulates the random nature of real-world maintenance and operations events by using Air Force data on fixed numbers and probability distributions, and (3) produces data from which credible short-range predictions of the behavior of random phenomena become possible. These predictions result in reasonably accurate estimates of the effects of proper manning and of the immediate effects of policy changes. 48 pp. Illus. See also P-1548 and P-1552.

● RM-2375 (AD 242708). **Analysis of the "delay and comparison circuit" for radar receivers in the presence of interference.** M. B. Marcus. 6-30-60. Unclassified.

An analysis of a method of reducing the heavy interference on a detection radar scope caused by energy radiated by neighboring radars with similar pulse-repetition periods. A threshold is placed at the receiver of the detection radar for each range element, followed by a delay and comparison circuit. If more than two interfering radars are present, only partial reduction of interference is achieved. 70 pp. Illus.

● RM-2385 (AD 219781) (out of print). **Survey of energy and oil demand projections for Western Europe.** Harold Lubell. 5-21-59. Unclassified.

A discussion of the past relationship between total energy consumption and gross national product in the countries of Western Europe. The memorandum also summarizes the several sets of base figures and projections for consumption of primary energy prepared by the European Coal and Steel Community in Luxembourg, the Organization for Economic Cooperation in Paris, and the Economic Commission for Europe in Geneva, all of which were made by relating growth in energy consumption to projections of gross national product. These energy projections are compared with a set prepared on a detailed product-by-product basis by the Standard Oil Company of California in San Francisco, and the oil consumption figures for Western Europe which emerge from the various energy projections are compared with the standard estimates for the non-Soviet world published annually by the Chase Manhattan Bank in New York. 28 pp. Illus.

● RM-2388 (AD 225224). **The simplex method for quadratic programming: notes on linear programming and extensions—part 51.** P. S. Wolfe. 6-5-59. Unclassified.

A computational procedure for finding the minimum of a quadratic function of variables subject to linear inequality constraints. The procedure is analogous to the simplex method for linear programming, being based on the Barankin-Dorfman procedure for this problem. A usable computational procedure for quadratic programming can be applied to the solution of elaborate nonlinear programming problems that economic models often present and to such problems as regression, efficient production, the "portfolio" problem, and convex programming. 43 pp. Illus.

RM-2396 (AD 228783). **On control of reactor shutdown involving minimal xenon poisoning.** M. Ash, R. E. Bellman, and R. E. Kalaba. 6-26-59. Unclassified.

An application of the theory of dynamic programming to the control of reactor shutdown involving minimal xenon poisoning. After a high-flux thermal nuclear reactor is shut down, the con-

centration of fission product xenon may rise for many hours as a result of the decay of fission product iodine into xenon-135. This results in reactor poisoning and may, with consequent loss of efficiency, postpone the time at which the reactor may be restarted. This poisoning may be minimized by carefully controlling the rate at which the neutron flux is decreased during the shut-down operation. The study shows how dynamic programming, assisted by high-speed digital computers with large memories, determines optimal control in this situation. 20 pp. Also published as P-1500.

- **RM-2398 (AD 237785). A game solution to a missile-launching scheduling problem.** S. M. Johnson. 11-25-59. Unclassified.

A game solution to the problem of scheduling missile launchings from bases that may come under enemy attack. Both sides, Blue and Red, know each other's initial missile strength at the outbreak of atomic war between the two countries. Blue wants to maximize and Red wants to minimize the expected number of successful Blue launchings. The problem is solved first for the case of a single launching site and then for a generalization to any number of sites. It is assumed that Blue must launch his missiles within a certain time period after the outbreak of war, that each Blue site can launch only one missile at a time, and that any Blue missile being launched will be destroyed if a Red missile hits near the launch site. 15 pp. See also RM-2723.

- **RM-2399 (AD 225229). Allocation of two types of aircraft in tactical air war: a game-theoretic analysis.** L. D. Berkovitz and M. Dresher. 6-30-59. Unclassified.

An analysis, as a two-sided war game, of the problem of allocating two types of aircraft (bombers and fighters) among three different air tasks (counter-air, air defense, and support of ground operations) in a multistrike campaign. It is assumed that a bomber can be used in either the counter-air or ground-support operations, while a fighter can be used in either the air-defense or ground-support roles. Optimal employment during the last strikes of the campaign consists in a concentration of all resources on support of ground operations. Optimal employment during the early strikes of the campaign requires randomization by both sides. 22 pp. Illus. Also published as P-1914. See also P-1533.

- **RM-2400 (AD 231761). A parametric study of certain low-molecular-weight compounds as nuclear rocket propellants—I: hydrogen.** F. J. Krieger. 6-30-59. Unclassified.

Part of a series devoted to a comparative study of certain low-molecular-weight high-hydrogen-content chemical compounds as propellants for nuclear-powered rockets. This memorandum presents the results for hydrogen, which, with its high specific impulse, is theoretically the most efficient nuclear-rocket propellant. However, its physical properties (e.g., low boiling point and low specific gravity) present formidable logistic and design difficulties. Other compounds, such as lithium hydride (LiH), ammonia (NH₃), water (H₂O), and methane (CH₄), are inferior to hydrogen in specific impulse but have compensating physical characteristics. Under certain conditions they may be more desirable than hydrogen as nuclear-rocket propellants. A parametric study, presented in this series of research memoranda, will help to determine what these conditions are. 46 pp. Illus. See also RM-2401–RM-2403 and RM-2807-PR.

- **RM-2401 (AD 246433). A parametric study of certain low-molecular-weight compounds as nuclear rocket propellants—II: ammonia.** F. J. Krieger. 7-31-59. Unclassified.

The second in a series of investigations which compare certain chemical compounds for use as possible propellants for nuclear-powered rockets. Although hydrogen, with its high specific impulse, is theoretically the most efficient nuclear rocket propellant, some of its physical properties (namely, its low boiling point and low specific gravity) present formidable logistic and design difficulties. While other compounds being considered are inferior to hydrogen in specific impulse, their physical properties in some cases make them less difficult to work with and, therefore, more desirable than hydrogen as nuclear-rocket propellants. A parametric study, presented in this series, will help to determine what these conditions are. This research memorandum gives the results for ammonia. 47 pp. Illus. See also RM-2400, RM-2402, RM-2403, and RM-2807-PR.

- **RM-2402 (AD 231762). A parametric study of certain low-molecular-weight compounds as nuclear rocket propellants—III: water.** F. J. Krieger. 7-31-59. Unclassified.

Part of a series devoted to a comparative study of certain low-molecular-weight high-hydrogen content chemical compounds as propellants for nuclear-powered rockets. Although hydrogen, with its high specific impulse, is theoretically the most efficient nuclear-rocket propellant, its physical properties (e.g., low boiling point and low specific gravity) present formidable logistic and design difficulties. Other compounds, such as lithium hydride (LiH), ammonia (NH₃), water (H₂O), and methane (CH₄), are inferior to hydrogen in specific impulse but have compensating physical characteristics. Under certain conditions they may be more desirable than hydrogen as nuclear-rocket propellants. A parametric study, presented in this series of research memoranda, will help to determine what these conditions are. This particular research memorandum presents the results for water. 46 pp. Illus. See also RM-2400, RM-2401, RM-2403, and RM-2807-PR.

- **RM-2403 (AD 231763). A parametric study of certain low-molecular-weight compounds as nuclear rocket propellants—IV: lithium hydride.** F. J. Krieger. 8-29-59. Unclassified.

Part of a series devoted to a comparative study of certain low-molecular-weight high-hydrogen-content chemical compounds as propellants for nuclear-powered rockets. Although hydrogen, with its high specific impulse, is theoretically the most efficient nuclear-rocket propellant, its physical properties (e.g., low boiling point and low specific gravity) present formidable logistic and design difficulties. Other compounds, such as lithium hydride (LiH), ammonia (NH₃), water (H₂O), and methane (CH₄), are inferior to hydrogen in specific impulse but have compensating physical characteristics. Under certain conditions they may be more desirable than hydrogen as nuclear-rocket propellants. A parametric study, presented in this series of research memoranda, will help to determine what these conditions are. The results for lithium hydride are presented in this research memorandum. 46 pp. Illus. See also RM-2400–RM-2402 and RM-2807-PR.

- Ø **RM-2404-AEC. Relativistic self-consistent calculation for the normal tungsten atom.** Stanley Cohen. 6-30-59. Unclassified.

A presentation of the relativistic self-consistent solution for the normal tungsten atom. A comparison is made between the energy eigenvalues for each of the subshells with corresponding experimentally determined energy-term values. 60 pp. Tables. See also RM-2272-AEC.

- Ø **RM-2405-AEC (AD 225226). Relativistic self-consistent calculation for the normal platinum atom.** Stanley Cohen. 6-30-59. Unclassified.

A presentation of the relativistic self-consistent solution for the normal platinum atom. A comparison is made between the energy eigenvalues for each of the subshells with corresponding experimentally determined energy-term values. 62 pp. Tables. See also RM-2272-AEC.

- RM-2406-AEC. Relativistic self-consistent calculation for the iron atom.** Stanley Cohen. 6-30-59. Unclassified.

A presentation of the relativistic self-consistent solution for the iron atom. A comparison is made between the energy eigenvalues for each of the subshells with corresponding experimentally determined energy-term values. 27 pp. Tables. See also RM-2272-AEC.

- **RM-2409 (AD 226411). Note on the strontium-90 fallout.** A. L. Latter and M. S. Plesset. 7-7-59. Unclassified.

A revision of an estimate made previously of the mean residence time of Sr⁹⁰ in the stratosphere from data recently made available by Libby. It is assumed that stratospheric fallout is uniformly distributed over the earth's surface and that the tropospheric fallout is confined about the latitude of the explosion. The mean stratospheric residence time is found to be between 6 and 7½ years. The previous estimate made in RM-1956, *Note on the Sr⁹⁰ Hazard*, determined this value to be between 4 and 6 years. 6 pp.

- **RM-2410 (AD 227309). The vulnerability of hypothetical rail transport for a mobile ballistic missile system.** W. R. Elswick. 7-9-59. Unclassified.

A description of the nuclear blast loading and response of some rail transport equipment that might be typical of that in a mobile rail ballistic missile system. The response of the rail vehicles is determined for several levels of blast "hardening," and the results are presented in terms of critical overpressures. 22 pp. Illus. See also RM-2270.

- RM-2413 (AD 234505). War gaming methodology.** M. G. Weiner. 7-10-59. Unclassified.

A description of the methodology of the Project SIERRA war games, including air, sea, ground, and logistic factors, as well as political and economic aspects. The research memorandum is intended for use as a reference by small staffs studying limited war by means of war-gaming techniques. The author discusses (1) background material on the general nature and usefulness of war games, (2) the preparations needed for war-game exercises, (3) the various techniques of free (two-sided) gaming, (4) the functions of the player and control teams and the procedures of play, and (5) game evaluation. As only war-gaming methods are considered, the results of the SIERRA limited-war studies are not included. 112 pp. Illus.

- RM-2414 (AD 312113). Dependence of East Germany on Western imports.** Horst Mendershausen. 7-17-59. Unclassified.

An attempt to determine the impact of a Western trade embargo against East Germany and the Soviet Bloc, a crisis that may be provoked by Soviet-backed East German measures against Berlin. The study discusses both the dependence of East Germany on trade with the West and East German vulnerability to allied economic countermeasures. The impact of such an embargo may depend in part on the forcefulness of Western responses in political and military fields in which economic countermeasures do not serve as substitutes. The outcome of a Bloc-wide embargo is dubious and must be weighed against the political difficulties of bringing it about. 59 pp. Tables.

- **RM-2415 (AD 227738). The Flight Operations Planner.** W. M. Jones, M. B. Shapiro, and N. Z. Shapiro. 7-16-59. Unclassified.

A study that examines the problems involved in planning the operations of large numbers of high-performance aircraft and that describes the role of the Flight Operations Planner (FLIOP). FLIOP is a digital computer program designed to reduce significantly the amount of time and effort necessary in calculating detailed flight plans for individual aircraft. By using FLIOP, the human planner can concentrate more on the general objectives considered and still retain the assurance that the final result is feasible. Although the B-47 and KC-97 aircraft are used for illustrative purposes, the techniques described are equally applicable to the various models of the B-52, B-58, B-66, KC-135, KB-50, F-101, C-124, C-130, and C-133, and can be applied to any fixed-wing-type aircraft. 98 pp. Illus. See supplement RM-2525.

- RM-2418 (AD 231548). The base repair cycle for the F-102 fire control system.** Annette Weifenbach. 7-21-59. Unclassified.

Data on the base repair cycle for the case of the F-102 fire-control system from Project FULL HOUSE and an attempt to indicate the supply implications. Several factors analyzed are the length of the base repair cycle and the percentages of malfunctions repaired at the base, requiring spare boxes and requiring parts in base repair. These malfunctions are classified into groups in which the boxes are sent to the depot for repair, are replaced with spares and sent to radar mockup for repair, are repaired and reinstalled in the same aircraft, and are repaired in aircraft or in field maintenance shops, not in mockup. In addition to furnishing inputs for other RAND research, this study may prove useful as a fund of basic information for Air Force logistics specialists interested in data of maintenance-operation interactions. 78 pp. Tables. See also RM-2365.

- **RM-2423 (AD 235145). Use of tolerance limits in missile reliability analysis.** Albert Madansky. 1-13-60. Unclassified.

A description of the use of statistical techniques to determine whether a missile system has achieved a specified minimal reliability requirement. The analysis demonstrates the use of tolerance limits to determine, for a given level of confidence, whether a minimal reliability requirement, previously

imposed on the system, is met. Tolerance limits for normal and exponential distributions are given, as well as nonparametric tolerance limits. The latter are compared with the parametric limits, and further properties of the parametric limits are discussed. Examples are included. 19 pp.

- **RM-2425 (AD 237380). Computing tetraethyl-lead requirements in the linear-programming format: notes on linear programming and extensions—part 52.** T. K. Kawarantani, R. J. Ullman, and G. B. Dantzig. 4-1-60. Unclassified.

An application of the linear-programming model to the problem of simultaneous determination of the quantities of various components of gasoline and tetraethyl lead to blend in order to form regular or premium grades of gasoline. The problem involves certain types of nonlinearities that are difficult to approximate. Linearization is accomplished by viewing the lead requirements of a blend first as a known general function of two variables, each of which is a linear function of the quantities in the blend. The general function is then approximated by a convex linear combination of a mesh of representative points. The approach discussed to solve this refinery problem may also be used by operations analysts to study other kinds of nonlinear situations of more direct concern to the Air Force. 19 pp. Illus. Also published as P-1545.

- **RM-2432 (AD 229374). Prices of producers' durables in the United States and the USSR in 1955.** A. S. Becker. 8-15-59. Unclassified.

A joint study with the Stanford Research Institute to provide USSR-US wholesale price ratios for 1955 for a representative sample of producers' durable equipment comprised of some 500 items. It is concluded that in 1955 the average price ratio for Soviet and American machinery was approximately six rubles per dollar. Price trends in the two countries since 1955 indicate that a lower ruble-dollar ratio should be applied in comparisons of current Soviet and American investment outlays on producers' durables. This work should be useful to analysts of the Soviet military budget and of Soviet weapon-system costs. 304 pp. Illus. See also RM-1443 and RM-1986.

- **RM-2438 (AD 225227). Khrushchev's major informal interviews with non-bloc leaders, January 1, 1957–August 1, 1959: a selected bibliography and chronology.** A. M. Jonas. 8-18-59. Unclassified.

A bibliography of all information released in *Pravda*, *Izvestiia*, and *Mezhdunarodnaia zhizn'* on the most important informal conversations Khrushchev has had with non-bloc leaders since January 1, 1957. This study is presented as an aid to analysts and officials to discern the real intentions of the Soviet Premier toward this country and its allies. 20 pp.

- RM-2445. Descriptive guide to a card directory of U.S. military radio communication equipment.** W. A. Backus, K. G. Heisler, and E. E. Reinhart. 7-31-60. Unclassified.

A guide to a card deck recording important characteristics of most of the radio communication equipment developed for, or under procurement by, the U.S. Armed Forces. The guide explains abbreviations and coding symbols used for data storage on the card deck, and gives instructions for card-sorting to retrieve information. 94 pp. Illus.

- ø ● **RM-2447-AEC. The emissive power of ionized hydrogen gas.** J. M. Green. 8-24-59. Unclassified.

A computation of the emissive power per atom of hydrogen for spontaneous emission into the continuous spectrum lying between the *L* and *M* edges. The results are quoted for temperatures between 3 and 30 ev and densities between 10^{15} and 10^{17} atoms per cubic centimeter. It is shown that under the stated thermodynamic conditions the complicating effect of free electron screening and bound electron screening may be neglected. Consequently the results are obtained from forms suitable for hand computation. 25 pp. Illus.

- RM-2451 (AD 235823). A model for assessing the effect of maintenance on missile launch probability.** E. E. Bean and W. H. McGlothlin. 9-23-59. Unclassified.

An analytical model designed as a tool to measure the effects of various operational modes and maintenance policies on ballistic-missile launch probability. The model is concerned with two elements of maintenance policy: operational mode and checkout frequency. The probability that the missile is alert when a launch order is given and will survive the countdown without failure is

calculated as a function of these two variable elements of maintenance policy. Although the model itself cannot determine an optimal maintenance policy, the logistics planner is aided in selecting one that will produce the maximum probability of launch in a prescribed time period and in evaluating the effect of preferred policies on launch capability. 41 pp. Illus.

- **RM-2454 (AD 232651). A materials-input index of Soviet construction, revised and extended.** R. P. Powell. 9-28-59. Unclassified.

A revision of RM-1872 and RM-1873, which estimate changes in the physical volume of construction in the USSR from 1928 to 1955 and contain an index of the volume of materials used in construction in terms of 1937 prices. This memorandum extends the index to 1958. New data recently published in the USSR are incorporated, leading to more reliable estimates of changes over time of the volume of construction in the USSR. These estimates serve as component indicators of Soviet national income and product and provide data for analyses of Soviet economic war potential. 98 pp. Tables.

- **RM-2455 (AD 232507). Misslogs: a game of missile logistics.** B. J. Voosen and D. D. Corona. 9-28-59. Unclassified.

A description of a simple logistics management game, called Misslogs. The game was developed to illustrate the interactions among operations, supply, maintenance, and personnel in a ballistic-missile squadron. Like its forerunners, Monopologs and Baselogs, the game is an educational device. It is designed for logisticians involved in the support of missile programs. The game does not duplicate all the logistics problems of a missile-alert operation. However, it gives the player, who must work within a limited budget, a clear-cut view of the tradeoffs he can make to achieve maximum readiness. 14 pp. Illus. See also RM-1917-1 and RM-2086.

- 3 ● **RM-2456-AEC. Probing the earth with nuclear explosions.** D. T. Griggs and F. Press. 9-28-59. Unclassified.

A suggestion that an international program of explosions be initiated for seismic purposes and that it be supported by adequate seismic instrumentation. The study indicates the advantages of using large chemical explosions and future nuclear explosions, detonated under the FLOWSHARE program, as controlled energy sources for these instrumental seismological experiments. The instrumentation network proposed at Geneva for nuclear test detection is specifically suggested as a possible instrumentation system. Such measures would improve our seismic capability to detect nuclear tests in the event of a test moratorium, and the scientific rewards would be tremendous. 43 pp. Illus.

- **RM-2460 (AD 237788). Derivation of two simple methods for the computing of radioactive fallout.** E. S. Batten, D. L. Iglehart, and R. R. Rapp. 2-18-60. Unclassified.

An attempt to develop a simple and realistic method for estimating the distribution and intensity of fallout. Close-in fallout from surface-burst weapons in the megaton range is considered. It is assumed that atmospheric turbulence has no effect on the fallout particles and that they fall with the terminal velocity of spheres. The study describes the actual mechanism of transport of fission products from a nuclear burst, derives a mathematical model representing the main features of the fallout process, and provides two simple methods for computing the fallout field. Information is given that permits the calculation of dose or dose rate, as well as the time of arrival of fallout at a point downwind. 54 pp. Illus.

- **RM-2461 (AD 237379). A parametric study of the performance of air-launched ballistic missiles.** G. K. Smith. 1-14-60. Unclassified.

An attempt to estimate the effect of three launch variables (namely, velocity, path angle, and altitude) on the performance of air-launched ballistic missiles. One- and two-stage missiles are considered for 200- to 1500-n-mi ranges at launch conditions varying from Mach 0.4 to 3.0 and from sea level to 60,000 ft. The results are presented in a series of curves for the convenience of the user. Although most of the calculations are based on a representative missile configuration flown on a maximum-range trajectory with a horizontal launch path, the data can readily be extrapolated to other missile trajectories. 39 pp. Illus.

- **RM-2462 (AD 241288). Signal detection in a noisy world.** W. H. Huggins. 5-3-60. Unclassified.

A discussion of the principles of recognizing signals on the basis of their waveform rather than their amplitude. These principles should be applicable to the design of future radar and sensor equipments which must operate in an increasingly noisy signal environment. 95 pp. Illus. Also published as Report No. AFCRC-TN-60-360, *Representation and Analysis of Signals—Part VII: Signal Detection in a Noisy World*, Department of Electrical Engineering, The Johns Hopkins University.

- **RM-2467 (AD 232874). Angular accuracy of a phased array radar.** L. E. Brennan. 10-22-59. Unclassified.

An approach to the theory of angle measurement with phased-array radars that use a set of separate antenna elements, each followed by an individual amplifier, in place of a more conventional receiving antenna. This study defines, for a phased array, the theoretical limit on angular accuracy that is set by receiver noise. It is shown that the accuracy of amplitude-comparison monopulse approaches this theoretical limit for large signal-to-noise ratios. The same accuracy can be achieved with phase-comparison monopulse by proper weighting of the individual signals. 36 pp. Illus. Also published as P-2027.

- **RM-2471 (AD 240303). A preliminary-design aid for studying component weight assignments in ballistic-missile payloads.** S. I. Firstman. 1-13-60. Unclassified.

A presentation of a method which can be used in determining the optimum allocation of weight among the elements of payload—warhead, guidance, and penetration aids—in a single-warhead ballistic missile. The analysis assumes that the missile is used against a particular type of defended point target and that, for the target in question, the weight-effectiveness relationship of each payload element is known. A hypothetical example illustrates the method for the case of a single missile assigned to each target. The formulation is then extended to the case in which several missiles are employed against a target. The success of the technique for design applications is heavily dependent on the design, intelligence, and employment estimates procured early in the research and development program of the missile. Nevertheless, the technique may be helpful in examining design trade-offs when uncertainty occurs in these estimates. 26 pp. Illus.

- **RM-2472 (AD 229912). On motives for "disarmament" research.** L. C. Bohn. 10-30-59. Unclassified.

An unsympathetic view of past disarmament research, an image of a military approach to the subject, and arguments for adopting this approach in a large-scale, continuing disarmament research effort. It is indicated that dissemination of a military concept of disarmament research is needed both inside and outside the government. Such an approach to disarmament will begin with the urgency of the military needs facing the nation in both the short and long run and will analyze the military gains and drawbacks of the widest possible variety of agreed military arrangements. 29 pp.

- **RM-2473-FF. Systems analysis and education** J. A. Kershaw and R. N. McKean. 10-30-59. Unclassified.

A study to assess the possibilities of making quantitative comparisons of education systems (that is, comparisons of specific systems with variants in which changes and innovations are incorporated). Only elementary and secondary schools are considered. Comparisons of this type to help administrators and others choose improved education systems will soon be feasible. However, it is necessary for more work to be done toward estimating the "input-output relationships" in education. 70 pp. Tables. See also RM-3009-FF.

- **RM-2474 (AD 241297). A stochastic force survival model.** F. H. Trinkl and C. R. Carr. 1-14-60. Unclassified.

An attempt to determine the effectiveness of various methods of protecting a defender's retaliatory capability by using a stochastic model of possible ICBM attacks. The model is applied to a specific set of protective measures for alert aircraft. The effectiveness of these measures is evaluated for attacks resulting in no warning, assured warning, and random warning. The model is flexible and can be used to evaluate other sets of protective measures as well as other possible components of the defender's force. 33 pp. Table.

- **RM-2476 (AD 241523). Symmetric games.** L. S. Shapley. 6-9-60. Unclassified.

A study concerned with the mathematical treatment of planning under conditions of conflict. A zero-sum two-person game is defined to be symmetric if it has an automorphism that permutes the players. This definition includes many games that do not have a skew-symmetric payoff matrix. It is shown how a general symmetric matrix game can always be reduced by block decomposition to skew-symmetric form. 14 pp. Illus.

- **RM-2480 (AD 235811). On the equivalence of the capacity-constrained transshipment problem and the Hitchcock problem: notes on linear programming and extensions—part 53.** D. R. Fulkerson. 1-13-60. Unclassified.

A demonstration of the equivalence of two kinds of network problems: the so-called capacity-constrained transshipment problem and the Hitchcock problem. The Hitchcock transportation problem is one of determining a minimal-cost shipping schedule from points of origin of a commodity to destination points for the commodity. It is assumed that each origin can ship directly to each destination, and that there are known quantities of supply at each origin, known demands at each destination, and known shipping costs from each origin to each destination. If this problem is extended by allowing the possibility of transshipment through origins, destinations, and other points, and also by imposing upper bounds on the amounts that can be sent between any two points, the new problem is known as a capacity, constrained transshipment problem. 18 pp. Illus.

- RM-2482 (AD 234041). The economics of parallel R and D efforts: a sequential-decision analysis.** R. R. Nelson. 11-12-59. Unclassified.

A mathematical model designed to help implement a major conclusion of RAND's continuing study of Air Force R&D policies (namely, that the most efficient way to conduct R&D may be to undertake parallel projects in the early and cheaper stages of a development program). The model is an initial attempt, through the use of sequential-decision theory, to explore parallel development in a more quantitative way. For example, how many competing projects should be run? And what are the factors that affect the answer to this question? The adoption of a parallel-path strategy by the U.S. Air Force as an R&D policy seems most clearly indicated when the technical advances sought are large, when considerable uncertainty exists as to which of several development alternatives is the best to pursue, and when the cost of prototypes is small compared with the total system cost. 43 pp. Illus. See also R-333.

- RM-2483 (AD 233261). The design of complex management control systems.** J. A. Postley. 11-11-59. Unclassified.

A study that urges the Air Force to revise its approach to the use of automation in designing its management-control systems. It is argued that more data-automation funds should be allocated to system design and that a prerequisite to effective system design is an understanding of the over-all objectives of the total system. It is proposed that the Air Force elevate the position of system designer to one of greater responsibility and entrust the design mission to new organizations created for the purpose. The Air Force is urged to employ more skilled and experienced design personnel and to ensure that the potential users of the system participate actively in the design work. 24 pp.

- **RM-2485 (AD 237091). Missile prelaunch confidence checkout: content and equipment design criteria.** S. I. Firstman and B. J. Voosen. 2-22-60. Unclassified.

A study concerned with designing automatic checkout procedures and equipment to maximize system operational capability. It is assumed that missile prelaunch checkout is designed to maximize the "commander's confidence" in the missile (defined as the probability that the missile contains no mission-failure-causing defects at the time of launch), and that the primary operational design problem is to determine which of the many missile functions to check in the limited time available for the checkout. Mathematical techniques are presented by which reliability estimates can be combined into a commander's confidence function, and a graphical method is developed to determine which tests are best accomplished in the limited checkout time to maximize this confidence. The technique is demonstrated by an example. 114 pp. Illus. See R-358.

- **RM-2486 (AD 234961). Impact wave propagation in columns of sand.** B. R. Parkin. 11-19-59. Unclassified.

A study of unidimensional compression waves in columns of sand. The medium is treated as an elastic-plastic continuum. It is assumed that each element of the substance exhibits a strain-rate effect such that, at a given strain, the plastic strain-rate is proportional to the difference between the compressive stress on the particle and that stress that would act on the element under static conditions. Published experimental results on the propagation of stress waves in sand are used as a basis of comparison between experiment and theory. The present theory gives satisfactory agreement with experiments on two dry sands. 151 pp. Illus. A continuation of research initiated in RM-2173. See abridgment P-2004-1.

- Ø ● **RM-2490-1 (AD 256812). Thermoelectric powerplants utilizing contained nuclear explosions.** G. A. Hoffman. 2-18-60. Unclassified.

A discussion of a hypothetical system involving the release of transient (or explosive) fusion pulses within a closed, underground rock cavity, lined by a heat exchanger. The heat energy thus confined may be slowly released, through the exchanger, to turboelectric generators. Major obstacles to the development of such a powerplant are outlined: the excavation of large cavities in rock, the definition of shock phenomena, and the large initial capital investment necessary. The study shows, however, that the technical problems are surmountable and that the cost of electric power produced by this system is comparable with the costs of conventionally generated electric power. In addition, such a system has an inherent simplicity of operation not characteristic of proposed sustained-fusion methods. 41 pp. Illus.

- **RM-2491 (AD 240836). A parametric study of surface-to-air missiles versus low-altitude targets.** F. A. Tatum and L. H. Wegner, Jr. 3-14-60. Unclassified.

An attempt (1) to determine the relative usefulness of penetration speed and low-altitude tactics for SAC mission planning and (2) to obtain data helpful in generalized studies of low-altitude penetration or defense. Some low-altitude penetration problems are solved to yield the number of salvos that a defense-missile installation can fire at an incoming target under various conditions of detection range, incoming-target speed, defense-missile speed, and time required to track and fire at targets. The computational procedure is described, and a set of sample solutions is given in graphic form. The curves are designed to examine a range of cases of penetration against short-range surface-to-air missiles with line-of-sight control systems. Within these limits the curves are highly generalized, thus enabling the user to provide his own inputs of kill probability that vary with type of warhead and other defense parameters. 84 pp. Illus.

- **RM-2492 (AD 241636). Survey of radiometric quantities and units.** William Viezee. 7-12-60. Unclassified.

An examination of the definitions of some fundamental quantities from the theory of radiative transfer. The present-day need is indicated for a uniform set of centimeter-gram-second units for the measurement of radiant energy, covering the entire electromagnetic spectrum and based on modern instrumentation. After examining certain fundamental concepts of electromagnetic wave propagation, the author surveys the common photovisual quantities and units, discussing them in terms of newer concepts and definitions. Finally, he examines specific units from the field of upper-atmosphere research. Tables of conversion factors are included for convenience in reducing these units to the centimeter-gram-second system. 42 pp. Illus.

- **RM-2494 (AD 235965). The control of industrial labor in the Soviet Union.** J. G. Gliksman and collaborators. 2-15-60. Unclassified.

An analysis of various measures used by the Soviet authorities to increase the productivity of industrial workers. The study shows that the Soviet central authorities have complete control over Soviet industrial labor. The control structure used to extract maximum effort from the labor force includes measures that affect the worker's real income and those that persuade or coerce him in other ways. The Soviets have obviously succeeded in making the USSR an industrial power of the first rank through the use of a basically coercive labor policy. However, in recent years the regime has been able to substitute for the older labor policy a more flexible and liberal one without sacrificing control over the labor force. 178 pp.

- **RM-2495 (Vols. I and II) (AD 241134). Indexes of Soviet industrial output.** N. M. Kaplan, R. H. Moorsteen, and E. S. Wainstein. 5-13-60. Unclassified.

Estimates of indexes of Soviet output of civilian industrial products from 1927/28 to 1958. The study provides a summary tabulation of the computed indexes, the underlying data which support these numbers, the sources for the data, and the methods used. Indexes are summarized for the years 1927/28, 1937, 1940, 1950, 1955, and 1958 for civilian machinery, other "producers' goods," consumers' goods, and all civilian industrial products. Similar index numbers are also presented for ferrous metals, fuels, electric power, chemicals, lumber, building materials, foods, and other consumers' goods. Our findings are compared with the indexes of other students of the Soviet economy and with the official indexes of the Soviet government. Consideration is also given to past trends in the rate of growth to indications of future Soviet growth rates, and to changes in productivity. 305 pp. Tables. Summarized in P-1848.

- **RM-2500. An evaluation of the human retinal burn problem arising from atomic detonations.** W. R. Elswick and H. H. Mitchell, M.D. 12-15-59. Unclassified.

A model developed to assess the damage to the human eye caused by thermal radiation from a nuclear burst and to determine some of the operational implications of the eye-burn hazard. It is shown that burns occur when the radiant intensity reaches a value of around 0.6 to 2.0 cal/cm² on the retina. Maximum distances for threshold burn, based on 2 cal/cm² from low-altitude bursts, can extend for as much as 25 mi (daytime) to 75 mi (nighttime) depending on the visibility and the yield of the weapon. The study emphasizes defense or test situations in which people may be exposed to thermal effects from air-burst nuclear weapons, such as air-to-air or surface-to-air missiles. 49 pp. Illus.

- **RM-2502 (AD 245101). Extension of the "WKB" approximation of high-frequency scattering by a dielectric sphere—part I: general expressions.** Zdenek Sekera. 6-30-60. Unclassified.

General mathematical expressions serving as analytical approximations for the far-field amplitude in high-frequency scattering of electromagnetic waves on a dielectric sphere. The approximations can be used to solve problems of radiative transfer in the visible and infrared spectrum in such media as natural fog and clouds, as well as in dense planetary atmospheres, especially if the scatterers vary greatly in size. 44 pp. Illus.

- RM-2506 (AD 235801). The simulation of human thought.** A. Newell and H. A. Simon. 12-28-59. Unclassified.

A discussion of the role of computers in human symbolic behavior. This memorandum describes (1) a method of studying human problem-solving thought processes through use of the computer; (2) an application of the method, whereby a general problem-solving program is constructed; and (3) the theory of human problem solving that emerges and that reflects the "insightfulness" and "directness" often observed in human problem solving. The authors attempt to show that technological advances have already occurred permitting a "theory of thinking" to be formulated and programmed on a computer. If human thinking can in fact be simulated by a computer, the age of "intelligent" machines will have arrived. 46 pp. Illus. Also published as P-1734.

- RM-2507-1-PR. The terms of Soviet-Satellite trade: 1955-1959.** Horst Mendershausen. 12-29-59. Rev. March 1962. Unclassified.

A study showing that on the basis of Soviet foreign-trade statistics up to 1959, the Soviet Union continued to charge more, and pay less, in trade with her Satellites than in trade with Free Europe. This price discrimination, which materialized despite Soviet denials, attests to the institutionalized restrictions of the Satellites' bargaining power toward the Soviet Union. The extent of this differentiation, varying from year to year, reflects the mechanism of intra-Bloc price fixing. Poland suffered less from Soviet price discrimination than did the Balkan countries. Such non-Bloc countries as Finland and Egypt, that depended strongly on Soviet trade, fared better than the Satellites but worse than Free Europe. 61 pp. Illus. Also published as P-1873. An extension of RM-2305.

- **RM-2508 (AD 236440). The measurement of missile reliability in pre-launch operating environments.** D. S. Stoller. 1-1-60. Unclassified.

A discussion of some of the basic concepts, measurement techniques, uses of data, and data-system implications involved in measuring missile reliability during the pre-launch phase of operations. A feasible reliability-measurement policy is outlined, and the use of a weapon-centered missile status log to obtain reliability data is explained. The study provides a basis for critical reliability planning information required in both force-employment analysis and support-requirement calculations. It is a product of continuing work designed to improve the maintenance and operations of both manned aircraft and missile systems at the base level. 34 pp. Tables. See RM-2131 for earlier results of the study.

- **RM-2510 (AD 234652). Nuclear weapons and limited war.** T. C. Schelling. 12-29-59. Unclassified.

Part of a broader investigation on the objectives of the general and limited war forces of the United States and on the relationship of these objectives to force composition. This study examines one kind of conflict situation, that of limited war. The nature and meaning of "limit" in war is investigated, with emphasis on the limit inherent in distinguishing between conventional and nuclear weapons. It is argued that this limit is derived not so much from physics as from psychology. How do limits evolve in limited war? What makes them stable or unstable? What gives such limits authority? What circumstances and models of behavior lead to the creation and mutual recognition of limits by parties to a conflict? These questions are considered as a prelude to discussing the use of nuclear weapons in limited wars. 15 pp. Also published as P-1620. See companion-piece RM-2515.

- **RM-2514 (AD 237092). Search rules for automatic fault location.** S. I. Firstman and B. Gluss. 1-15-60. Unclassified.

A derivation of probabilistic rules to help determine the preferred order of conducting tests to locate a faulty part in the minimum expected time of search. A two-step search routine for finding the faulty module, and then the faulty component within the module, is considered. Methods of estimating the required parameters are discussed, and a technique is presented for employing the fault symptoms when developing the search process. The simplicity of the rules encourages their use in the maintenance checkout of ballistic missiles and other systems. 36 pp. Illus. See abridged version P-1857. See also R-358.

- **RM-2515 (AD 234653). The role of theory in the study of conflict.** T. C. Schelling. 1-13-60. Unclassified.

Part of a broader investigation on the objectives of the general and limited war forces of the United States and on the relationship of these objectives to force composition. This study develops the hypothesis that political-military strategy on the international level is an underdeveloped science. The author believes that requisite to the study of international relations is a systematic theory of conflict encompassing such concepts as deterrence, "brinkmanship," "arms race," and "accidental war." The need for such a theory is shown, some of the ingredients and characteristics of the theory are suggested, and the way in which it might be applied to practical problems of international affairs is examined. 52 pp. See abridged revision P-1648. See also companion-piece RM-2510.

- **RM-2516 (AD 240432). A review of binary boundary layer characteristics.** J. F. Gross, J. P. Hartnett, D. J. Masson, and C. Gazley, Jr. 6-18-59. Unclassified.

An examination of the binary boundary-layer problem in connection with providing better estimates of surface-cooling methods for use with hypersonic vehicles, such as ICBM nose cones. A binary boundary layer is one in which some foreign substance has been injected to alter the properties of the flow, notably its heat-transfer characteristics. The mechanism of laminar binary boundary-layer flow is discussed in mathematical terms, and five different analyses involving a variety of injected substances are reviewed. Generalized expressions are then developed for predicting heat-transfer and skin-friction performance in the presence of mass-transfer cooling for laminar flow over a flat plate. The results indicate that different foreign materials (e.g., hydrogen, carbon dioxide, and iodine vapor) injected into the boundary-layer stream reduce heat-transfer and skin-friction coefficients by

an amount that depends on the molecular weight of the injected material. In conclusion, mass-transfer cooling in a turbulent boundary layer and sublimation cooling are considered. 111 pp. Illus. Also published as P-1729.

- **RM-2519 (AD 246199). A mathematical model of the human external respiratory system.** G. B. Dantzig, J. C. DeHaven, I. Cooper, S. M. Johnson, E. C. De Land, H. E. Kanter, and C. F. Sams, M.D. 9-28-59. Unclassified.

The results of a mathematical simulation of the external respiratory function to illustrate the thesis that important subsystems of the human body can be studied by mathematical programming techniques that have been used to program and control complex military and industrial systems. The model constructed shows the process occurring when air is breathed and mixed with venous blood in the lungs, which results in exhaled air and arterial blood. From the long-range viewpoint, such simulation may provide a powerful new tool for biological investigations. 109 pp. Illus. Also published as P-1811. See also P-2048 and P-2139.

- **RM-2523 (AD 238095). Similar solutions of compressible laminar-boundary-layer equations for binary mixtures.** T. Y. Li. 3-9-60. Unclassified.

An investigation of the binary boundary-layer problem arising from the injection of a foreign material from the body surface into the boundary layer. The rather complex characteristics of the laminar-boundary-layer equations for binary mixtures are reduced to ordinary differential equations yielding similar solutions, namely, numerical results that are generally applicable to a variety of physical situations. This reduction is made possible (1) by making several simplifying assumptions about fluid properties and (2) by introducing a characteristic temperature function (T^*) that permits certain variables and properties of the binary mixture to be expressed in the simple terms of a pure gas. This study has direct bearing on current and future hypersonic vehicle design. Since hypersonic flow around an ablating sharp nose is important in nose-cone design, the results obtained are also applicable indirectly to research in missile discrimination. 41 pp.

- **RM-2525 (AD 237155). Addendum to RM-2415, *The flight operations planner*.** W. M. Jones and M. B. Shapiro. 2-9-60. Unclassified.

An extension of RM-2415, which deals with problems involved in planning the operations of large numbers of high-performance aircraft and describes the role of the Flight Operations Planner (FLIOP). FLIOP is a digital-computer program designed to reduce significantly the time and effort necessary to calculate detailed flight plans for individual aircraft. Since this earlier publication, additional features have been incorporated into FLIOP. They provide information about course and distance from a known point, allow the user to designate en route points, and change the method of determining winds so that the results are a more accurate approximation of the effect of the aircraft's motion on the standard vector-deviation quantities used. This study examines these and other features, and discusses certain technical operations of the routine on the IBM 704. 27 pp. Illus.

- **RM-2527 (AD 235350). General equations of motion of a satellite in a gravitational gradient field.** R. H. Frick and T. B. Garber. 12-9-59. Unclassified.

A development of the general equations of motion for a satellite, including both orbital motion and rotation about the center of mass of the vehicle. It is found that these two elements of motion are coupled, so that for extremely eccentric orbits, the vehicle begins to tumble relative to the instantaneous vertical. 60 pp. Illus.

- **RM-2529 (AD 245407). Powerplants for atmospheric and surface vehicles on Mars.** W. H. Krase. 4-10-60. Unclassified.

An investigation of powerplants suitable for use on Mars. The powerplants studied are atmosphere-breathing systems using nuclear and chemical heat sources, chemical rockets, and a rocket-turbine in which rocket-chamber exhaust feeds a turbine to produce shaft power. Chemical-energy sources include mono- and bipropellants, reactions with the atmosphere, and propellants that can be made from native materials. The rocket-turbine, when designed for high-energy cryogenic propellants, appears to be an economical and relatively lightweight power unit, with possible applications in other planetary environments, including that of the Earth. 36 pp. Illus. A companion piece to RM-2539. See also RM-2567.

RM-2532 (AD 232871). Soviet strategic ideas, January, 1960. H. S. Dinerstein. 2-19-60. Unclassified.

An appraisal of Premier Khrushchev's speech of January 14, 1960, and of Defense Minister Malinovskii's speeches of January 14 and 19, in which new and important changes in Soviet strategic thinking are revealed. The study discusses the Soviet claims that missiles have assumed a primacy in their arsenal supplanting manned aircraft, the apparent new realization that the initial phases of general war may be brief and decisive, the claim that Soviet power may be used as a shield against any aggression against Bloc nations, and the assertion that "marvelous new weapons" are in the brief cases of Soviet scientists. This research memorandum, along with companion-piece RM-2534, may be of particular value to the intelligence community. 35 pp. A supplement to R-326 (out of print). Also published as P-1925. See also RM-2557.

- **RM-2533 (AD 236844). Notes on n -person games—VI: on solutions that exclude one or more players. L. S. Shapley. 3-3-60. Unclassified.**

A characterization of those n -person games that can be solved by excluding one or more players from a share of the proceeds and then solving the ensuing "fraction" of the original game. It is shown that a discriminatory solution exists if, and only if, there is one group of players strong enough to enforce all possible distributions of proceeds in the original game that exclude the "out" players. Some previously known results that follow as special cases of this general condition are given. 13 pp.

- **RM-2534 (AD 232872). The significance of Chinese Communist treatment of Khrushchev's January 14 speech on strategy. A. L. Hsieh. 2-19-60. Unclassified.**

An examination of Communist China's reactions to the speech of Premier Khrushchev of January 14, 1960. The study shows how the new and important changes in Soviet strategic thinking may affect Sino-Soviet strategic relations. For example, the Chinese have used Khrushchev's reference to the role Russia will play in disarmament discussions to assert that no international disarmament agreement will be binding on China without her formal participation and adherence. Other Chinese reactions to this speech are divulged both by what is commented on and by what is apparently deliberately reported without comment. This memorandum, along with companion-piece RM-2532, may be of particular value to the intelligence community. 21 pp. See also RM-2557. Incorporated in *Communist China's Strategy in the Nuclear Era*, published by Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1962. \$4.50.

- **RM-2535-RC. Observations on contemporary Burma. W. C. Johnstone. 5-9-60. Unclassified.**

A discourse on contemporary Burma, covering Burma's foreign policy, various political crises, and the role of the Communist bloc in Burma. Observations are made concerning (1) the political and economic stability of Burma as an independent nation, (2) the reasons for a strong anti-Communist attitude in Burmese politics, (3) the possibility of Burmese government receptivity to some kind of Asian defense or mutual security agreement, and (4) the "grand strategy" approach of the Chinese Communists toward Burma and India. 75 pp.

- **RM-2536 (AD 241043). The use of Bayesian techniques for predicting spare-parts demand. W. H. McGlothlin and R. Radner. 3-1-60. Unclassified.**

A discussion of spare-parts-demand prediction that may be based on two sources: engineering estimates and data accumulated from actual experience. Materiel officers have often wished to augment original engineering estimates with data drawn from unfolding experience. The advantage of the method suggested is that it blends information from both of these sources by using weighted averages. Through Bayesian techniques, moreover, early hypotheses can be revised in accordance with engineering changes in the equipment, changes in operations, or other modifications in the original situation. The study does not develop new methods for making initial estimates or new techniques of prediction based solely on later experience. However, if improvements along these lines should become available, the Bayesian procedures can be correspondingly modified. Already these techniques have proven useful in RAND's Logistics Systems Laboratory. 68 pp. Illus. See also RM-2701.

- **RM-2538 (AD 238096). Studies in machine translation—10: Russian sentence-structure determination.** D. G. Hays and T. W. Ziehe. 4-1-60. Unclassified.

A description of the computer program developed at RAND to determine the internal structure of a Russian sentence. This process—by finding each grammatic connection within each sentence—makes translation possible and enables the computer to construct the sentence in the output language and to print out a translation. Sentence-structure determination is preceded by text preparation and glossary development. RAND machine-translation research has produced (1) a simple, flexible computer program that can analyze word order and determine grammatic structure in Russian sentences, (2) a descriptive Russian grammar, coded for the computer, which is complete and precise within the limits of the subject matter and size of the text on which it is based, and (3) a glossary of Russian physics. Although the grammar and glossary cannot be transferred to any other language, the method of research and the computer program can be applied at once to computer analysis of any inflected language. 78 pp. Illus. See also RM-2061, RM-2063–RM-2066-1, RM-2068, RM-2069, and RM-2655.

- **RM-2539 (AD 245345). Vehicles for exploration on Mars.** T. F. Cartaino. 4-30-60. Unclassified.

An examination of the kinds of vehicles that may be used for exploration by manned expeditions after landing on Mars. The types of manned vehicular systems considered are ambulatory, surface car, helicopter, and airplane. The performance and operational characteristics of these vehicle systems are compared, and within the limits of our knowledge of the Martian environment, all four types are shown to be feasible. A unique rocket-turbine propulsion system, and methods of achieving vehicle-range extension, are also described. 32 pp. Illus. A companion piece to RM-2529. See also RM-2567.

- **RM-2541. Soviet computer technology—1959.** W. H. Ware. 3-1-60. Unclassified.

An account of a trip taken by two RAND computer specialists as part of an eight-man technical delegation representing the United States National Joint Computer Committee and its member societies. The genesis of the delegation and its itinerary in the Soviet Union are traced. The state of the art in Soviet computer technology as observed by the delegates is examined, showing the development, construction, applications, routines, and components of the major Soviet computing machines. Impressions are included on Soviet education, the role of the Academy of Sciences of the Soviet Union, and Chinese developments in computer technology. Also presented are photographs of Soviet personnel, places, and machines. 205 pp. Illus. See also RM-2799-PR. Published in *IRE Transactions on Electronic Computers*, March, 1960.

- **RM-2542 (AD 236075). The Sabatier reaction for inorganic recovery of oxygen in manned space capsules.** S. H. Dole and A. R. Tamplin. 2-25-60. Unclassified.

A method (applicable to manned space vehicles) for recovering oxygen by an inorganic chemical process. The method is based on work started about 1902 by the French chemist Sabatier, whereby carbon dioxide is reacted with hydrogen to produce water and methane, which is discarded. Oxygen is recovered from the water by electrolysis, and the resulting hydrogen is cycled back into the reaction process. Compared with processes using algae suspensions, this process is lighter and less cumbersome and requires far less electrical energy. It can be made compact and virtually automatic. The method is not dependent on radiation and environmental temperature fluctuations, and it can be efficiently used for manned space missions lasting from a month to several years. 59 pp. Illus.

- **RM-2544 (AD 253000). Soviet national income and product, 1928–48: revised data.** A. Bergson, H. Heymann, Jr., and O. Hoeffding. 11-15-60. Unclassified.

A revision of the calculations of Soviet national income that have been presented in previous RAND publications (R-253, R-255, and RM-2101). RAND Report R-367-PR, *The Real National Income of Soviet Russia since 1928*, deflates the current-price accounts to obtain estimates of Soviet national income in "real" terms. To complete the latter study, it was essential to review and revise the current-price estimates for 1928 to 1948, which were published several years ago. This revision examines the large volume of statistical data, and other relevant information, published in the Soviet Union since that time. It introduces a few methodological changes, tending toward greater consistency in the calculations for different years. It also corrects some deficiencies and errors found in the original calculations. With minor exceptions, these recent efforts have confirmed the accuracy of RAND's earlier assessments of Soviet national income and product. 155 pp. Tables.

- **RM-2552 (AD 237790). Approximate confidence limits for the reliability of series and parallel systems.** Albert Madansky. 4-4-60. Unclassified.

A method of determining approximate confidence limits for the reliability of a complex mechanism. Such a mechanism may be described in terms of a system built up from a number of different types of components. The components comprising the complex mechanism are combined into a "parallel system," a "series system," or a "series-parallel system." Based on observed failures of the individual components, a method combining these observations is discussed to provide confidence limits on the reliability of the mechanism. It is assumed that the failures are independent and that failures of a given component follow a binomial distribution with unknown parameter, the component reliability. The large-sample properties of the likelihood-ratio test are then used to construct the appropriate confidence limits for the reliability of the system. The procedure is compared with existing techniques, and an example is given. 13 pp. Also published as P-2401.

- **RM-2556 (AD 242934). Neutron fluxes in air: a comparison of Monte Carlo code computations by RAND, Los Alamos, and Sandia.** J. I. Marcum. 7-1-60. Unclassified.

A comparison of three computational methods for describing the flow of neutrons from an energetic point source through an air medium. The RAND method assumes a nonhomogeneous atmosphere of varying density with height. To study the effect of locating the source near an air-ground interface, air cross sections are used in place of ground cross sections, but with ground density below the interface. The codes developed at Los Alamos and Sandia assume an atmosphere of unvarying density. The Los Alamos code uses actual ground cross sections, while the Sandia code does not consider the interface problem. The number of neutrons per square centimeter (flux) is calculated by these several codes for starting energies ranging from a fraction of an electron volt to 14 million electron volts, at distances up to 1500 meters (15 mean free paths). It is concluded that all three codes are probably operating correctly and that the major differences can be explained by the differing inputs. 62 pp. Illus.

- **RM-2557 (AD 236090). West European comments on Soviet posture as presented in Khrushchev's speech of January 14, 1960.** E. W. Schnitzer. 3-22-60. Unclassified.

A review of West European press reactions to the speech of Premier Khrushchev on military affairs, delivered to the Supreme Soviet January 14, 1960. The study indicates defense attitudes, trends in military and political thinking, and public morale in Western Europe. The reactions from West and East Germany, Switzerland, Britain, and France are discussed in connection with military aspects (the announced troop cut shows a Soviet position of strength), Soviet foreign policy (a change of policy leading to international relaxation is not evidenced), and Soviet domestic conditions (the troop reduction arises from an economic necessity that will help ease the strains imposed by the Seven-Year Plan). There is some speculation to the effect that certain emphases in Khrushchev's speech betray an internal conflict between the Soviet Premier and a conservative military group. 30 pp. See also RM-2532 and RM-2534.

- **RM-2561 (AD 244107). Communist strategy in Laos.** A. M. Halpern and H. B. Fredman. 6-14-60. Unclassified.

An analysis of the military actions in Laos in the summer and fall of 1959 and of their political-military background. The events are treated as a special case of limited war. Contrary to normal expectations, the initiative was on the side of the Free World. Communist actions were fully coordinated among three partners but were reactive in nature. Both sides operated under severe restraints, which kept the action to a minimum level. The *status quo* at the termination of real combat was not wholly satisfactory to either side. Military action could recur in this area under varying circumstances. 173 pp. Illus.

- ● **RM-2562-AEC. Concealment of underground explosions.** A. L. Latter. 3-16-60. Unclassified.

Results of the Cowboy experiments on the decoupling of underground nuclear explosions. These experiments show that the principle of decoupling by means of a large hole is correct. The decoupling factor of 300 is still considered the best estimate for a hole in salt relative to a tamped shot in Nevada tuff. The most surprising result of Cowboy is that decoupling is not an all-or-none

effect. If the elastic limit of the medium is exceeded, the decoupling factor is reduced, but only gradually. As a result it appears possible to explode a 20 KT device in a cavity no bigger than some which already exist, without producing a signal that can be detected by the Geneva system. 8 pp.

RM-2566 (AD 241637). Aircraft compartment design criteria for the Army deployment mission. W. F. Sharpe. 5-1-60. Unclassified.

An examination of our cargo airlift capability in connection with the Army deployment mission. The bulk of Army deployment cargo is vehicular, unlike the small units typical of peacetime cargo. Cargo floor area (square footage), not payload capacity (weight), is the major limiting factor on many present and future air carriers of Army vehicles and other equipment. The analysis shows that because of the space limitation, an average of 51 lb of deployment cargo can be loaded per square foot of aircraft floor area. When this planning factor is applied to the payload-range curves of aircraft now in service, revised curves result. While the adjustment imposes only a minor change in the curve for the C-124, a significant reduction is indicated in the capability of both the C-130 and C-133. 53 pp. Illus. See abridged version P-2082.

• **RM-2567 (AD 251921). Summary of orbital and physical data for the planet Mars.** D. S. Kirby. 8-1-60. Unclassified.

A presentation of orbital and physical data for Mars to show the range of uncertainty implicit in the observational determination of planetary constants rather than a definitive set of values. Many of the differences in the available Mars "standard data sheets" can be explained by uncertainties surrounding two fundamental quantities, from which other physical constants are derived: the mass and radius of Mars. Starting with these two observable quantities, the author explains and derives other related physical constants of interest. To these are added photometric, spectroscopic, and radiometric data, and a discussion of orbital elements. 58 pp. Illus. See also RM-2529 and RM-2539.

RM-2572 (AD 247711). The LP-II data-processing system. K. H. Labiner and J. D. Tupac. 9-10-60. Unclassified.

Another in a series of studies describing Laboratory Problem II (LP-II), an experiment designed to evaluate alternative logistic policies and procedures for an intercontinental ballistic-missile force of the 1963 to 1965 time period. This memorandum describes the advanced data-processing system used in LP-II, which serves as a medium for information flow and management control and which is designed to be compatible with real-world situations. The authors discuss the organizations initiating the inputs, the information and data flows, the internal machine processing, and the machine outputs and reports. 84 pp. Illus.

• **RM-2578 (AD 247383). Determining checkout intervals for systems subject to random failures.** Milton Kamins. 6-15-60. Unclassified.

A method for determining appropriate time intervals between periodic checkouts for strategic, defense, and possibly tactical systems that have an exponential failure distribution. Algebraic equations are presented that express the relationship of time between checkouts to in-commission rates and costs. These equations are used to find the checkout interval that results in the maximum value of the readiness-to-cost ratio. The analysis is then extended to cover smaller groupings, such as subsystems or even components. Finally, monitored or continuous checkout is examined and compared with checkout at the preferred periodic intervals determined previously. A large number of examples are evaluated and summarized in graphic form, so that use of the method does not usually require extensive computations. 90 pp. Illus. See R-358.

• **RM-2579 (AD 244947). Atmospheric entry of manned vehicles.** Carl Gazley, Jr. 1-20-60. Unclassified.

A discussion of the requirements of a reliable space system for returning human occupants to earth. The study examines the problems associated with the vehicle's leaving orbit and assuming an initial entry path; its deceleration dynamics during entry; and means of protecting the interior from the effects of aerodynamic heating. Two vehicle types meeting the basic requirements for manned entry are (1) a blunt, dense vehicle with little or no aerodynamic lift and a low-temperature ablation-cooling system, and (2) a radiation-cooled vehicle using a very light drag brake or lifting surface to achieve high-altitude deceleration. 49 pp. Illus. Also published as P-1890.

- ØRM-2580-AEC (AD 246628). Fermi-Dirac averages of the free-free hydrogenic Gaunt factor. J. M. Green. 6-30-60. Unclassified.

A study of the effects of very high electron densities on the absorption of radiation by free-free electron transitions. The absorption coefficient is expressed in terms of a dimensionless quantity known as the Gaunt factor. The nonclassical effect of exclusion is obtained by averaging the energy dependent hydrogenic Gaunt factors of Latter and Karzas against the Fermi-Dirac electron distribution. Tables of the Fermi-Dirac averages of the hydrogenic Gaunt factor are presented over an appropriate range of thermodynamic states and photon energies. It is demonstrated that whenever the densities are high enough to require the use of the Fermi-Dirac averages, the effect of electron screening also becomes important. It is shown how the tables of Fermi-Dirac Gaunt factor integrals may be altered to determine the effect of electron screening. 112 pp. Illus.

- RM-2581 (AD 247322). A discussion of a midcourse guidance technique for space vehicles. F. T. Smith. 10-3-60. Unclassified.

An analysis of a midcourse guidance system for space vehicles. Midcourse guidance is described as those processes of measurement, computation, and control that occur between the termination of the powered ascent trajectory and the arrival of the vehicle somewhere in the vicinity of its destination. As an illustration, the study considers the problem of midcourse guidance for a vehicle on a trajectory from the earth to the moon, using range-only measurements. The same technique might be used to "guide" a 24-hour equatorial satellite, first in establishing it in orbit and later in periodically compensating for perturbing forces. The technique could also be adapted for use in manned interplanetary flight, involving measurements made from the vehicle. 62 pp. Illus.

- RM-2585 (AD 253585). A survey of thermal accommodation coefficients. J. P. Hartnett. 3-19-60. Unclassified.

An evaluation of the available literature on thermal accommodation coefficients describing the mechanism of heat transfer to a body immersed in a rarefied gas. For various reasons, previous experimental investigations have failed to produce satisfactory measurements of these coefficients, notably in the low-density flow regime where the mean free path of molecular travel becomes comparable to or greater than the physical dimensions of the body. Possible ways of correcting these defects are advanced, and the need for new measurements is discussed. 56 pp. Illus.

- RM-2587 (AD 241289). An application of a network flow model to personnel planning. William Gorham. 6-24-60. Unclassified.

A model to help determine, among alternative training and retraining programs, those that promise either the best match of manpower to requirements, and/or those that can meet requirements at minimum cost. Several factors recommend the network flow model for application to this aspect of personnel logistics. First, those considerations that must be studied to determine training flows lend themselves readily to simulation. Secondly, of the several alternative mathematical techniques, the network formulation appears to cope best with the very large systems entailed in programming Air Force personnel training. Finally, once the first set of flows has been computed, successive solutions based on changed input data can be obtained quickly and inexpensively. 90 pp. Illus. See also RM-2611.

- RM-2592 (AD 252242). The possible use of atomic nuclei as a direction reference in inertial space. W. H. Culver. 12-13-60. Unclassified.

A description of a proposed direction sensing device (called a nuclear magnetic gyro) as a possible means of obtaining improved accuracy and performance over conventional navigation devices. The author argues that it should be possible to use aligned atomic nuclei to replace a conventional gyroscope as a direction reference in an inertial guidance system. Various schemes for reading out the alignment direction are discussed, including a rotating pickup coil. A superconducting shield would protect the aligned nuclei (of a helium isotope) from the disturbing effects of external magnetic fields. The fundamental physical principles and limitations of the idea are explained in the hope that this material will stimulate further research leading to the development of a successful device. 50 pp. Illus. See also RM-1852.

- **RM-2595 (AD 240594). The Chinese genie: Peking's role in the nuclear test ban negotiations.** A. L. Hsieh. 6-20-60. Unclassified.

A study of the manner in which Communist China's atomic aspirations affect her military thinking and foreign policies on the question of disarmament and the nuclear test ban issue. Communist China has indicated that she will be able to make atomic bombs in the "not too distant future." It is concluded that China is prepared to use the concern over her exclusion from the nuclear test ban negotiations to enhance her bargaining position with both the USSR and the U.S. Communist China has declared that without her participation and adherence a disarmament agreement cannot have any binding force on her. Later this spring she announced a further prerequisite: that her participation is inconceivable unless she is accorded recognition. At some point, the U.S. will have to decide if the accession of China to the agreement merits political and perhaps major military concessions to Peking. There is, however, the very real possibility that China may not be willing to relinquish her atomic aspirations at any price. 26 pp. Also published as P-2022.

- **RM-2597 (AD 243215). An algorithm for the mixed integer problem: notes on linear programming and extensions—part 54.** R. E. Gomory. 7-7-60. Unclassified.

An algorithm for the numerical solution of the "mixed integer" linear-programming problem in a finite number of variables. In problems of this type, the variables are constrained by linear inequalities and by the requirement that certain of the variables assume only integral values. The algorithm is an extension of the cutting plane technique for the solution of the "pure integer" problem. 19 pp. A revision of P-1885.

- **RM-2600 (AD 250380). Cratering from a megaton surface burst.** H. L. Brode and R. L. Bjork. 6-30-60. Unclassified.

Calculations on the cratering and ground motion in a rock medium due to a two-megaton surface burst. The theoretical approach assumes a two-dimensional hydrodynamic model, and it is used to determine the motions involved in the cratering from a large-yield surface burst. The technique is found to work well and to check with experimental observations. It is shown that the primary cause of cratering for such an explosion is not "airslap," as previously suggested, but rather the direct action of the energetic bomb vapors. High-yield surface bursts are therefore less effective in cratering by that portion of the energy that escapes as radiation in the earliest phases of the explosion. The cratering action and ground shock from large-yield explosions is of primary importance to problems of hardening military installations as well as to the peaceful use of nuclear explosions. 60 pp. Illus.

- **RM-2601 (AD 245175). Automatic indexing: an experimental inquiry.** M. E. Maron. 8-10-60. Unclassified.

An experimental investigation of a statistical technique for automatically classifying (indexing) documents according to their subject content. A computing machine reads a document and, on the basis of the occurrence of selected clue words, decides to which of many subject categories the document belongs. (The present method, if refined and extended, might possibly be applied to the indexing of intelligence documents in the Air Force.) 46 pp. See updated version P-2180.

- **RM-2602 (AD 246819). Social patterns in the Hungarian Revolution.** Paul Kecskemeti. 7-20-60. Unclassified.

An attempt to indicate the reasons for the Hungarian communist regime's succumbing to popular forces in the Hungarian Revolution of October, 1956. Both the internal crisis in the Hungarian Communist Party and Moscow's repeated direct intervention in Hungarian developments are described as contributing factors leading to the regime's downfall. The study assesses the role played by the intellectuals, workers, peasants, and youth in the revolution. Hungarian events are related to Soviet efforts to exert power in East Germany, Czechoslovakia, and Poland from 1953 to 1956. General observations are also presented on the conditions under which revolution can break out in regimes in which political power is highly centralized. 241 pp. Published under the title, *The Unexpected Revolution, Social Forces in the Hungarian Uprising*, by Stanford University Press, Stanford, California, 1961. \$4.75.

- **RM-2607 (AD 254862). The forces between conducting spheres in a uniform electric field.** M. H. Davis. 1-26-61. Unclassified.

A solution to the problem of computing the forces which act on pairs of conducting spheres (charged or uncharged) in the presence of an electric field as a basis for determining the effect on the behavior of cloud droplets. Two important approximations are made: The spheres are assumed to be conducting rather than dielectric bodies, and the distortion of the droplets when they are close together is neglected. Neither approximation should lead to an appreciable error for small cloud droplets. The results are presented in generalized form, and related coefficients are plotted. 55 pp. Illus.

- Ø ● **RM-2610-AEC. Some statistical properties of level and line distributions in atomic spectra.** S. A. Moszkowski. 11-8-60. Unclassified.

An investigation, from the statistical viewpoint, of the properties of level and line spectra due to mutual interactions among electrons. It is shown that the first and second moments of the spectra (weighed by the appropriate statistical weight factors) vary in a regular way with the number of particles in the shell, the second moment reaching a maximum in the middle when the shell is about half full. The detailed shape of the distribution, called the "strength function," is also examined using a number of simplified models. If only close together single particle orbits are mixed by the interactions (which is the situation usually assumed in shell model-type calculations), then the strength function for levels is essentially exponential and that of lines somewhat like a Gaussian. 74 pp. Illus.

- **RM-2611 (AD 250725). Concepts for estimating Air Force manpower requirements for planning purposes.** M. C. Heuston. 12-1-60. Unclassified.

A description of a conceptual methodology to assist both Air Force planners and contractors, engaged in early development planning, to estimate total gross requirements of manpower for future weapon and support systems. The personnel subsystem concept, developed by the Air Research and Development Command, is used as the framework around which to organize the major parametric conditions that affect manpower estimates for advanced systems. The sequence of steps required to predesign a personnel subsystem is described. This early design information helps provide the basis for estimating manpower requirements in a total system context. From the organization structure viewpoint, this total includes general functions such as operations, unit administration, maintenance, support, and prorated shares of Air Force logistic support and higher headquarters administration. 43 pp. Illus. See also RM-2587.

- **RM-2617 (AD 250238). Geological covering materials for deep underground installations.** S. M. Genensky and R. L. Loofbourow. 8-4-60. Unclassified.

An examination of some twelve geological configurations in the continental U.S. (including Alaska) which may be suitable for the construction of large underground installations and at the same time possess the ability to attenuate blast waves generated by a ground-burst nuclear weapon. The study indicates that although it is advisable to construct large subterranean installations in hard, competent (i.e., self-supporting) rock, such geological media as uncompacted rock offer interesting alternatives. In addition, a possible method of protection from blast waves in the high-frequency range, beyond that provided by the natural overburden, is suggested. 61 pp. Illus.

- RM-2618 (AD 244698). "Deterrence" and surprise attack in Soviet strategic thought.** A. L. Horelick. 7-1-60. Unclassified.

A study showing the effect that current Soviet doctrine on strategic surprise has on the Soviet attitude toward deterrence. The relevant public statements of Soviet leaders are analyzed, with particular emphasis on Khrushchev's January 14, 1960, speech to the Supreme Soviet on military affairs. The author discusses (1) the early post-Stalin Soviet debate on the reliability of deterrence in the light of the increased danger of surprise attack, (2) the conditions under which a prolonged state of mutual deterrence is acceptable to Khrushchev, and (3) current Soviet efforts to extract political advantage from the strategic equation by asserting strategic superiority. 39 pp. Also published as P-2016. Published in the *Royal Canadian Air Force Staff College Journal*, 1960.

- RM-2619-RC (AD 248078). Recent communist tactics in Indonesia.** G. J. Pauker. 8-15-60. Unclassified.

A description of current communist penetration in the Indonesian government. While communist advances are substantial, the party does not yet control strategic positions essential for a coup. By

fostering a reputation for "respectability," the Indonesian Communists hope to eventually bring the party to power by peaceful means. The new communist tactics are made possible by President Sukarno's policies, which attempt to offset the Army and the Communist Party, so that he may avoid becoming the political captive of either and may maintain his personal dictatorship. It is concluded that only Sukarno's retirement from active politics will prevent the Communist Party from coming to power eventually by a demonstration of genuine mass appeal. 25 pp. See also RM-2637-RC, P-1452-RC, and P-1514-RC.

- Ø • RM-2624-AEC. Cavity explosion calculations for the Cowboy program. H. L. Brode. 8-5-60. Unclassified.

A presentation of calculations corresponding to the cavity explosions of the Cowboy program. These were spheres of high explosive ranging from 20 to 2000 lbs detonated in spherical cavities of 12 and 30 ft diameters. Wall pressures as a function of time are given, together with the explosive properties influencing the wall pressures. Some comparisons with measured pressures are also included. The explosion history of one typical problem (20 lbs in 12-ft cavity) is examined in an appendix. 48 pp. Illus.

- Ø • RM-2625 (AD 261027). Some results on new classes of matched filters. David Middleton. 7-12-61. Unclassified.

An examination of a new class of more advanced filters for which the design criterion is the automatic decision process that occurs when the signals are detected or measured in noise. (For example, in the detection of a radar signal the process might involve deciding whether or not a target is present, or it might involve measuring the signal in the sense of determining the position or velocity of a radar target.) The study shows how a new class of filters which have optimal properties is conceived theoretically, and indicates the approach to their design and construction for actual use. 39 pp.

- Ø RM-2627-PR (AD 265337). Cost of a hardened, nationwide buried cable network. J. M. Chester. 10-1-60. Unclassified.

An investigation of the cost incurred from building and operating a new, hardened buried cable communication network of nationwide coverage. The costs are expected to run as high as \$2.4 billion for a 100-psi configuration to \$3.4 billion for the same network hardened to 1000 psi. The study assumes that this sample network—encompassing some 54,000 route miles and serving some 200 facilities—will replace the present soft communications network so far as military and national security traffic is concerned. It is assumed that investment costs will be borne by private industry, while military users will pay for the service in the form of leasing fees. The Air Force share is estimated to vary from \$550 million for a 100-psi network to as much as \$780 million for a 1000-psi configuration. 63 pp. Illus.

- RM-2636-RC. The Lao elite: a study of tradition and innovation. J. M. Halpern. 11-15-60. Unclassified.

An attempt to define the Lao elite and to show their relationship to other groups in the population. The study discusses the various pressures for change and points of friction. Although many strains exist within the social system of Laos, they do not appear to be sufficiently serious to bring about the disintegration of the present political structure, which despite its clearly marked traditional base is certainly capable of modification. This excludes a *coup d'état* by the Pathet-Lao. An understanding of the cultural attitudes and social values of the elite might aid in the development of a group that can exert effective local leadership toward goals compatible with Western interest and values. 100 pp.

- RM-2637-RC (AD 249507). The role of the military in Indonesia. G. J. Pauker. 9-1-60. Unclassified.

A discussion of Indonesia's second decade of independence. The conditions are strikingly different from those that prevailed during its first five years as a new state. Current trends toward military authoritarianism, and possibly even totalitarianism, are indicated. Martial law has been invoked. An elected parliament has been replaced by an appointed one. Civil war is going on in the form of guerrilla operations in Java, Sumatra, and the Celebes. The economy is running down. The reasons for this national tragedy are explained, and the tactics used by President Sukarno to maintain his position are described. 74 pp. See also RM-2619-RC, P-1452-RC, and P-1514-RC.

RM-2638 (AD 320144). The design and test of a zero-wave-drag ring-wing configuration. F. K. Browand (Massachusetts Institute of Technology, Naval Supersonic Laboratory). 6-15-60. Unclassified.

A procedure for the design of a zero-wave-drag ring-wing configuration by symmetrizing the body and wing pressure distributions. Wind tunnel tests of this RAND design indicate appreciable wave-drag cancellation. The boundary layer affects the inviscid pressure distribution sufficiently to cause increases in the friction drag, which must be accounted for in performance evaluations. The extension of the design procedure to cover a broader class of problems is discussed. 119 pp. Illus.

- **RM-2641 (AD 252753). A study of the feasibility of detecting nuclear explosions by means of antineutrinos.** R. O. Hundley. 12-19-60. Unclassified.

A study of the feasibility of using an antineutrino detector of the Reines-Cowan type to detect nuclear explosions. (The antineutrino is an elementary particle found, for example, in some radioactive decay processes. It is capable of penetrating the mass of the earth.) The presence of antineutrinos resulting from a detonation is inferred by the production in the detector of two more easily detectable particles, the neutron and the positron. It appears that a detector with a volume of about one billion cubic feet would be needed for detection of a 1-KT detonation at 100 km, or a 100-KT detonation at 1000 km. These results clearly indicate that the method is not feasible. 46 pp. Illus.

- **RM-2643. Oblateness perturbations of near-earth satellites.** T. W. Mullikin. 10-25-60. Unclassified.

An approximate solution to the orbit of an artificial earth satellite, taking into account the oblateness of the earth (i.e., its departure from a spherical shape). The technique used is to simplify the nonlinear differential equations of celestial mechanics by changing the independent variable from time to a suitable angle. 34 pp.

- **RM-2646 (AD 250237). Grouping and dependency theories.** D. G. Hays. 9-8-60. Unclassified.

A comparison of two theories of sentence structure. One theory groups words into phrases, and phrases into larger phrases, until each complete sentence is grouped into a single unit. The other treats connections between words, making the whole structure of each sentence into a "tree," resembling an organization chart. The study shows that results obtained by the two theories are similar but not identical: for a given grouping, several trees are possible, and vice versa. Since RAND is almost the sole proponent of the tree theory, the similarities and differences between what RAND and others are doing are emphasized. 20 pp. Illus. Also published as P-1910.

- **RM-2648 (AD 250239). Values of large games—I: a limit theorem.** L. S. Shapley and N. Z. Shapiro. 11-2-60. Unclassified.

An examination of the mathematical behavior of existing n -person solution concepts for large games as n becomes very large. The study analyzes what happens in a weighted majority game when a block of votes is broken up and distributed among a large number of players. The value of the game to the other players is shown to converge to a limit as the size of the largest fragment tends to zero. An explicit expression is given for the limit. 24 pp. See also RM-2649, RM-2650-PR, and RM-2651.

- **RM-2649 (AD 254863). Values of large games—II: oceanic games.** J. W. Milnor and L. S. Shapley. 2-28-61. Unclassified.

Part of a continuing effort to extend the applications of n -person game theory. A value theory is developed for voting games in which a sizable fraction of the total vote is controlled by a few major players and the rest is distributed among a continuous infinity of individually insignificant minor players. The latter are referred to collectively as an "ocean," to suggest the total lack of order or cohesion that is assumed. 32 pp. Illus. See also RM-2648, RM-2650-PR, and RM-2651.

- Ø ● **RM-2650-PR (AD 269105). Values of large games—III: a corporation with two large stockholders.** L. S. Shapley. December 1961. Unclassified.

Part of a broader investigation to provide a mathematical method of predicting the behavior of large groups of people. Institutions with large numbers of competing participants are common in political and economic life (e.g., markets, exchanges, corporations, presidential nominating conventions, and legislatures). These institutions can be considered as n -person games. However, game theory has not yet been able to designate the fundamental principles of "mass competition" to help

explain how the institutions operate in practice. This memorandum discusses the "oceanic" theory of voting games in which a large fraction of the total vote is controlled by a few people. 26 pp. Illus. For other publications in this series, see RM-2648, RM-2649, and RM-2651.

- **RM-2651 (AD 246277). Values of large games—IV: evaluating the Electoral College by Montecarlo techniques.** I. Mann and L. S. Shapley. 9-19-60. Unclassified.

An illustration of the power-index concept of game theory, provided by an analysis of the Electoral College of the United States as a game. Despite its seemingly transparent rules of operation, the electoral-vote method of choosing the president and vice-president contains a number of peculiarities in its a priori distribution of power that can only be revealed by laborious numerical computations. The most noteworthy power anomaly disclosed is a general bias in favor of the large states that makes their electoral votes consistently worth more than those of the small states, although the difference is relatively minor. The study contains an account of the game model, the computed power indices, and the "Montecarlo" sampling schemes invented to make the computation possible. 46 pp. Illus. See also RM-2648, RM-2649, and RM-2650-PR.

- **RM-2655 (AD 252609). Studies in machine translation—12: a glossary of Russian physics.** A. S. Kozak, C. H. Smith, and Members of the RAND ALDP Group. 10-14-60. Unclassified.

A record of the actual Russian forms and words found in over a quarter-million running words of contemporary physics text. The frequency of occurrence is given for each form. This research memorandum is the first to give such data on a significantly large selection of Russian scientific text, although data on Russian literary language have been published. It also gives one or more English equivalents for each form, and a grammatical description of each. The present glossary will eventually be supplanted by an expanded glossary, based on a larger amount of text and giving comparative data about the languages of several fields of science. In the long run, basic work in linguistics hopefully will furnish the theory and data required to satisfy Air Force needs for automatic language-data processing. 311 pp. Tables. See also RM-2061, RM-2063–RM-2066-1, RM-2068, RM-2069, and RM-2538.

- RM-2656. Base-depot requisitioning pipeline times.** A. Heuston, R. M. Paulson, and A. H. Rosenthal. 11-1-60. Unclassified.

An analysis of the total Air Force pipeline time (transceiver time plus depot-processing time plus transportation time) required to serve the customer at four ZI bases and six overseas bases during a six-week period in 1959. Thus the total process studied is (1) the number of hours between the time a requisition leaves a base and the time of receipt at the Air Materiel Command depot, (2) the number of days from the beginning of the process until time of shipment, and (3) shipment time. Less than half of the pipeline times were within the expected standards. A full 40 per cent of orders were still unfilled at the end of the waiting period of 45 days after the last requisition was made. In other words, the standards were not met by a large margin during the time under study. 132 pp. Illus.

- RM-2657 (AD 253001). The Chinese Communist line on neutralism.** A. M. Halpern. 11-19-60. Unclassified.

An analysis of the manner in which the Communist Chinese government has made use of appeals to Asian neutralism in the period since November 1957. The manipulation of neutralism is treated as an important aspect of the basic Sino-Soviet policy problem of the time, that of prudent and effective use of a position of strength. Besides aiming at weakening the United States military position in Asia, the Chinese during 1960 formulated the goal of overthrowing imperialism on a world-wide scale. The study concludes with a postscript on the Moscow Declarations of December 5, 1960, and their possible effect on future Chinese Communist foreign policy. 43 pp. See companion study P-2026. Presented before the Third International Conference of Sovietologists and Sinologists at Tokyo, Japan, in September 1960.

- ◊ ● **RM-2660 (AD 256411). Pressure response within an enclosure subject to a blast wave.** W. R. Elswick. 3-1-61. Unclassified.

Part of a broader investigation concerned with the design of shelter structures to withstand the blast or pressure-rise effects of a nuclear explosion. A generalized mathematical model is presented of the

rise of pressure with time within an enclosure as a function of enclosed volume, leakage-opening area, static overpressure, and nuclear-weapon yield. The results are shown graphically. Their applicability to the design of protected enclosures is illustrated by two examples of personnel shelters: a small home shelter, and a considerably larger arrangement housing up to a hundred people. 39 pp. Illus.

- Ø • RM-2665-AEC. The effect of plasticity on decoupling of underground explosions. A. L. Latter, E. A. Martinelli, J. Mathews, and W. G. McMillan. 11-22-60. Unclassified.

A study of the effect of plasticity, including work hardening, on decoupling underground explosions for cavities designed to give full decoupling according to the Geneva specification (70 cubic meters per ton of explosive energy) as well as small (overdriven) cavities designed to give partial decoupling. The results show that plasticity plays no role whatsoever for full-decoupling cavities, even those at great depth in which some plastic flow occurs during construction of the cavity. For overdriven cavities at great depth, plasticity affects the decoupling factor by an amount which depends on the degree of overdriving and the depth as well as the detailed stress-strain curve of the medium. For cavities at a depth of about one kilometer and in a medium like salt, which exhibits a reasonable amount of work hardening, the decoupling factor will be at least as great as that obtained in the overdriven Cowboy experiments and could be appreciably greater. 34 pp. Illus.

- RM-2668 (AD 249503). Design criteria for rotating space vehicles. S. H. Dole. 10-18-60. Unclassified.

A discussion of a problem associated with manned missions in space, that of weightlessness versus simulated gravity. The condition of weightlessness, with its attendant disadvantages, can be overcome in manned spacecraft on prolonged missions by designing the vehicle so that it can be rotated about an axis to simulate gravitational effects at its outer rim. However, certain combinations of rotation rate and radius of rotation are unacceptable, for various physiological reasons. In this study a "design envelope" encompassing all acceptable combinations of rotation rate and radius is defined, and five boundary lines enclosing the region of interest are suggested. Only those data points that fall within the envelope are advised for use in the design of future rotating manned space vehicles intended for long-duration flight, such as interplanetary trips. 24 pp. Illus.

- RM-2671 (AD 252908). A method for determining approximate propulsion cutoff conditions for ballistic interplanetary trajectories. L. N. Rowell. 12-29-60. Unclassified.

A method for determining approximate propulsion cutoff conditions for any ballistic-type interplanetary trajectory. It is assumed that the heliocentric portion of the trajectory originates near perihelion of the heliocentric orbit. The necessary computation is made without using a large-scale digital computer, yet with sufficient accuracy for many planning and engineering design studies. 64 pp. Illus.

- Ø RM-2675 (AD 259555). Minimum-weight proportions of pressure-vessel heads. G. A. Hoffman. 6-13-61. Unclassified.

A derivation of minimum-weight shapes of head closures for cylindrical pressure vessels. Torispherical, ellipsoidal, and Biezeno-type heads with constant and varying thickness are investigated, with constancy of enclosed volume and supporting structure being considered. This study, which has applications in the design of rocket booster tanks, indicates possible weight savings of 5 to 11 per cent over a reference least-thick hemispherical head. 47 pp. Illus. See abridgment P-2137.

- RM-2678 (AD 252909). Measurements of sphere drag from hypersonic continuum to free-molecule flow. D. J. Masson, D. N. Morris, and D. E. Bloxson. 11-3-60. Unclassified.

The results of tests conducted in a Hotshot-type wind tunnel with air at stagnation temperatures of approximately 2500° K and 9000° K and with helium at stagnation temperatures varying from 1600° K to 4000° K. For these tests the mach numbers in the test section varied from 11 to about 60 with free-stream Reynolds numbers ranging from 15,000 down to about 30. All of the test results can be correlated by a parameter that is proportional to the ratio of the mean free path behind the shock wave to the shock-detachment distance. The measured drag coefficient increases from the continuum value (0.92) to a level in the free-molecule flow regime of approximately 2.0. 48 pp. Illus. Also published as P-2110.

- **RM-2681 (AD 252910). The role of data input in automatic data processing systems.** S. L. Pollack. 12-9-60. Unclassified.

A study primarily concerned with data input, defined as the generation, collection, and transmittal of data to be entered into a computer for automatic processing. The study describes the several stages of data input, a few problem areas, and some of the techniques and recent equipment development useful for solving them. Certain basic principles that can be used as a basis for improving data input are (1) data-input specialists should be employed more widely; (2) input error prevention, detection, and correction routines should be incorporated in data systems; (3) data input problems should be considered when an electronic data processing system is designed; and (4) the Air Force should plan, at this time, for the role that data input will play in automatic data processing systems in the 1965 to 1975 time period. 42 pp. Tables. See abridgment P-2246.

- Ø ● **RM-2682-1-PR (AD 269285). Theory of ionized trails for bodies at hypersonic speeds.** P. S. Lykoudis. 5-29-61. Rev. 10-5-61. Unclassified.

A review of the basic equilibrium and nonequilibrium aspects of hypersonic trails to develop methods for use in ascertaining the shape and weight of re-entry bodies. A universal solution is found for the velocity and enthalpy (heat content per unit mass) distribution behind the body in terms of the coordinate defining the shape of the bow shock wave. The length of the trail produced by a blunt body at constant velocity is shown to be approximately proportional to the local atmospheric density, the drag coefficient, and the body's cross-sectional area. This analysis permits rapid estimates of the velocity and energy distribution in ionized trails, which previously required extensive machine calculations. 66 pp. Illus. See also RM-2818-PR.

- Ø ● **RM-2685 (AD 256277). Standardization of automatic test and checkout equipment: a preliminary discussion.** A. A. Barbour, S. I. Firstman, and M. Kamins. 11-25-60. Unclassified.

A guide for evaluating the technical and economic feasibility of standardizing automatic test and checkout equipment. Five levels of standardization are defined: component, functional module, functional assembly, tester assembly, and testing system. Two opposing opinions are presented on the desirability and feasibility of standardization. Technical factors relevant to standardizing automatic checkout equipment are discussed, as well as factors dealing with economic feasibility. The potential effects of such standardization on weapon-system cost/effectiveness are indicated. In addition, some pertinent points of inquiry concerning the various levels (above the component level) are outlined. 59 pp. Illus. See R-358.

- Ø ● **RM-2686-AEC. Static deformation of a plastic medium.** Jon Mathews. 1-18-61. Unclassified.

A presentation of static solutions for the displacement and stresses in a plastic medium surrounding a spherical cavity in which a hydrostatic pressure exists. Various cases are considered, including the case in which the pressure unloads the plasticity caused by the formation of the cavity. Some numerical examples are given. 36 pp. Illus.

- RM-2693 (AD 252243). Neutron branching processes.** T. W. Mullikin. 1-4-61. Unclassified.

An application of the theory of branching processes to nuclear reactors with spherical, slab, or rod geometries. New results are given for the extinction probability of a supercritical reactor (i.e., the probability that the process is of finite duration). These results suggest a new computational method for estimating the critical dimension and the steady-state flux of a reactor. 37 pp. Also published as P-1985. See also RM-2317.

- **RM-2695 (AD 257269). System and total force cost analysis.** David Novick. 4-15-61. Unclassified.

A description of the aims, concepts, and methods of military cost analysis as developed by RAND's Cost Analysis Department. The publication is basically concerned with estimating costs for proposed military activities so that informed choices can be made among them. The study replaces and extends R-287, *Weapon-system Cost Methodology* (withdrawn), by considering in more detail the underlying principles of cost analysis and by examining methods for analyzing the costs of total force structures as well as individual systems. The earlier cost categories are refined, particularly

by providing categories for research and development activities which now constitute an increasing share of system costs. By generalizing methods and examples, the analysis is extended to support and control systems as well as weapon systems. The usefulness of cost sensitivity analysis is explained and illustrated by examples, and methods are described for estimating system manpower requirements. 154 pp. Illus.

- Ø • **RM-2696-AEC. Power recovery from the Kilauea Iki lava pool.** G. C. Kennedy and D. T. Griggs. 12-12-60. Unclassified.

A proposal that the Kilauea Iki lava pool be scientifically probed. Some methods of large-scale electric power production are also suggested. The lava pool created by the eruption of Kilauea Iki in 1959 contains nearly 100 million tons of molten lava. This presents a unique opportunity for the AEC PLOWSHARE program to learn how to make industrial use of subsurface pools of molten rock such as those that might be formed by deep underground PLOWSHARE explosions. 28 pp. Illus.

- Ø • **RM-2701 (AD 255161). Application of the Bayes technique to spare-parts demand prediction.** W. H. McGlothlin and E. E. Bean. 1-3-61. Unclassified.

A proposal of an improved procedure for direct use in predicting the demand for spare parts. The study examines a specific aspect of the supply problem, that is, the estimating of spare-parts demand rates at times when data from operational experience are still relatively sparse. While the Air Force has been relying in such instances on a priori estimates made by the initial provisioning conference, shifting to a computed demand rate only at a later time when experience was judged to be "extensive," the study urges a gradual and systematic transition from the one to the other. Even "limited" demand experience is thus used. At any point of time, a priori estimates and observed demands are weighted by expected accuracy. For carrying out this procedure, the study shows how to prepare and use a weighted average of the two sources of data. Graphs, formulae, and a step-by-step procedure for making demand-rate predictions are included. 53 pp. Illus. See also RM-2536.

- RM-2702 (AD 258297). An examination of the use of statistical aggregates to improve management control of large organizations.** H. M. Wagner. 4-25-61. Unclassified.

An examination of the manner in which statistical aggregates or index numbers may be used to improve management control over the operations of lower echelons within large and partially decentralized organizations. The facets of inventory management emphasized are (1) the enforcement of scientific inventory policies, (2) the encouragement of economic consumption of inventory, and (3) the adjustment of system operations to changes in inventory demands. In each of these cases, the study discusses how top management may use statistical aggregates to encourage the fulfillment of specified standards and to detect deviations from these standards as they occur. 291 pp. Illus.

- Ø **RM-2715 (AD 259327). Structures under repeated blast loadings.** Paul Weidlinger. 3-3-61. Unclassified.

An examination of the vulnerability of a target subjected to a series of blasts. It is shown that properly designed elasto-plastic structures are capable of surviving the cumulative effects of repeated blasts if each blast is less intense than a destructive single blast. The probability of kill, taking into account the cumulative effects from a series of blasts, is determined and is not significantly higher than the probability of kill obtained by neglecting cumulative damage. 36 pp. Illus.

- Ø • **RM-2716 (AD 256666). Equations of perturbed motion for a satellite in a nearly circular, nearly equatorial orbit.** F. T. Smith. 2-27-61. Unclassified.

The derivation of a set of differential equations which define the perturbed motion of a celestial body. These equations are based on a particular set of orbital parameters suitable for orbits of small or zero eccentricity, since no singularities occur in the equations when the orbital eccentricity vanishes. The parameters may also be used to define orbits of small inclination. The application of this set of equations to orbit computation and orbit transfer problems is discussed. 86 pp. Illus.

- Ø • RM-2722 (AD 256957). **Decision rules for the disposal of excess Air Force stock.** J. W. Houghten and R. H. Holton. 2-1-61. Unclassified.

An investigation concerned with the disposal of excess items of Air Force materiel at the wholesale, or depot, level. Part of the problem of carrying on an intelligent disposal function is the question of which items should be coded as excess and put up for disposal. The study develops rules for doing this. It also considers similarities and differences between the disposal problems of the Air Force and private industry and discusses the possible impact of surplus military items on the open market. Two disposal rules are presented: screening possible items for disposal, and determining precisely how many units should be coded as excess. The application of these decision rules should repay the Air Force (1) by reducing the number and expense of judgment errors that occur when some costs may not be taken into account, (2) by putting stock disposal on a routine basis, and (3) by easing explanations on the subject of surplus disposal procedures. 97 pp. Illus.

- Ø RM-2723 (AD 264783). **Optimal timing in missile launching: a game-theoretic analysis.** M. Dresher and S. M. Johnson. 3-1-61. Unclassified.

A formulation of a scheduling problem which is analyzed as a two-person game. It is assumed that Blue plans to launch a missile during some specified time interval. Prior to a launching, Blue must expose the missile for a time period during which the missile is vulnerable to attack and may be destroyed by Red. Prior to its exposure, Blue's missile is assumed to be underground, where it may be pinned down for a time interval or possibly destroyed by a Red missile. An attempt is made to determine the optimal time for Blue to launch his missile and for Red to attack Blue. Various game models are considered in which these types of vulnerability are introduced as stochastic elements. Optimal strategies are also described. 28 pp. Illus. See also RM-2398.

- RM-2731 (AD 257935). **An experiment in aircraft status prediction.** R. E. Johnson. 5-24-61. Unclassified.

A description of a method of aircraft status prediction and of an experiment based on certain Air Force data. One aspect of weapon system management is the ability to control hour-to-hour and day-to-day readiness levels for aircraft and missiles. This study attempts to develop a method for prediction purposes that would be useful for periods of hours rather than days. The author relies on a Markov chain method, finding it better than simple reliance on either the present status of the unit's aircraft or on some average status pattern. The method takes advantage of information about the future provided by (1) schedules relating to flying and to periodic maintenance, (2) historical data, and (3) current status information. It is suggested that certain systems now under development would be benefited by taking into account the needs of status prediction at such times as the systems become operational. 45 pp. Illus.

- Ø RM-2735-PR (AD 268940). **Operational criteria for the design of missile readiness testing programs and equipment.** J. R. Brom and S. I. Firstman. December 1961. Unclassified.

Part of a broader investigation concerned with Project ACE, a study of automatic test and checkout equipment for complex weapon systems. This memorandum attempts (1) to demonstrate how missile readiness is influenced by equipment, weapon system, and operational factors and (2) to develop aids toward determining a readiness testing program for the entire missile. To these ends, the study develops a mathematical model that relates missile readiness to relevant physical and operational factors. 113 pp. Illus. An abridgment of this memorandum is available as RM-2735-PR (Abr.), *Operational Criteria for Automatic Missile Readiness Testing*, by S. I. Firstman, February 1962.

- Ø • RM-2740 (AD 257936). **D-layer ionization loss rates.** C. M. Crain. 4-14-61. Unclassified.

An examination of certain ionization phenomena in the region of the earth's atmosphere from about 50 to 90 kilometers, the D-layer. The concentration of electrons in this region tends to change with the incidence of solar radiation, being greatest in the daytime and falling off during the nighttime or during solar eclipses. Factors in this process are rates of attachment and detachment of electrons to molecules of oxygen (and possibly water vapor) and recombination rates of ions and electrons. The ionization effects attributable to cosmic radiation are also examined. As a study in the basic

physics of the upper atmosphere, this research memorandum provides part of the background for investigations of the effects of high-altitude nuclear explosions on radio communications. It is thus tied in with research leading to improved methods of postattack command and control. 39 pp. Illus.

- Ø RM-2750 (AD 260059). **An omnibus of briefing papers on analysis of automatic checkout equipment and aids to its design.** S. I. Firstman, A. A. Barbour, J. R. Brom, N. Jordan, M. Kamins, K. H. Meyer, and B. J. Voosen. 6-12-61. Unclassified.

A series of briefings summarizing the major aspects of RAND's work on automatic checkout equipment (Project ACE). The briefings deal with design criteria and system implications of automatic checkout equipment and with methods of planning its effective operation. A bibliography for Project ACE is included. 158 pp. See also P-2567.

- Ø RM-2751 (AD 263219). **On the solution of two-stage linear programs under uncertainty: notes on linear programming and extensions—part 55.** G. B. Dantzig and A. Madansky. 8-10-61. Unclassified.

An extension of RM-2752 which discusses methods for compensating for uncertainty in linear-programming problems. These methods replace the random elements by expected values or by pessimistic estimates of these values, or recast the problem into a two-stage program so that, in the second stage, the "inaccuracies" in the first stage can be compensated for. This research memorandum is concerned with the last of these methods and investigates the conditions under which the first-stage decisions are optimal. Formulas are also given for using various existing computational algorithms to obtain an optimal solution. 35 pp. Also published as P-2039.

- Ø • RM-2752 (AD 257816). **Methods of solution of linear programs under uncertainty: notes on linear programming and extensions—part 56.** Albert Madansky. 4-6-61. Unclassified.

A discussion of the uncertainty involved in most practical linear-programming problems. Possible ways to compensate for this uncertainty are to replace the random elements by expected values or by pessimistic estimates of these values, or to recast the problem into a two-stage program so that, in the second stage, the "inaccuracies" in the first stage can be compensated for. This memorandum examines the one-stage linear program under uncertainty, indicating the relations between these ways of reducing the effects of uncertainty. 25 pp. See extension RM-2751.

- Ø RM-2754 (AD 264430). **Glossary of terms on national security.** S. M. Genensky and O. Helmer. September 1961. Unclassified.

Definitions for some important and frequently used terms in discussions of national security issues. The objective is to provide a broad basis of agreement on fundamental concepts used in debating policy. 16 pp. Also published as P-2346.

- Ø • RM-2756-PR (AD 274035). **Human factors in automatic checkout equipment: an annotated bibliography.** Dunlap and Associates, Inc. March 1962. Unclassified.

An annotated bibliography of 103 publications dealing with human factors in automatic checkout equipment. The publications are grouped in five subject categories: general philosophy and review of automatic checkout methods, maintainability directives and guides, models of the maintenance process, human performance of checkout and fault-isolation tasks, and specific checkout systems. 93 pp.

- Ø RM-2763 (AD 256872). **The Khrushchev succession problem.** Myron Rush. 5-1-61. Unclassified.

An assessment of the question of Soviet succession in Khrushchev's 68th year, the fourth year of his rule. The study indicates that a succession crisis is inevitable when Khrushchev ceases to exercise dictatorial powers. The depth of the crisis, however, will depend on certain circumstances at the time. Only if the Soviet regime is seriously weakened by such a crisis is it likely that Soviet foreign policy will be redirected from its primary aim of subverting the West and achieving a communist world order. Moreover, while economic and social progress poses a serious problem for the regime and is certain to have important political consequences, it cannot, in the author's view, change the regime's totalitarian character in the years ahead unless it is seriously weakened by a succession crisis. 62 pp. Also published as P-2283.

Ø RM-2764. Industrial equipment spectrum signatures. H. A. Myers. 6-16-61. Unclassified.

A survey of the radiation characteristics (spectrum signatures) of electrical and electronic equipments (such as rectifiers, welders, power lines, switching devices, ignition systems, induction heaters, and electric motors). Equipment signatures compiled from interference reports indicate that some industrial activities radiate strongly enough to cause interference, and to be detected and identified, at ranges up to a few miles. Most of the energy is concentrated in the low-frequency portion of the spectrum. The equipments were measured at Douglas Aircraft Company in Santa Monica, using Stoddart Aircraft Radio Company receivers. The graphs show strong and unique signatures in the 30 to 3000 bands. 62 pp. Illus.

Ø • RM-2765-PR (AD 263583). Some characteristics of the elliptic Gaussian distribution. R. N. Snow. September 1961. Unclassified.

An extension of RM-330, *The Circular Coverage Function*. Although it is usually satisfactory to approximate the distribution of the point of impact of bombs, missiles, and other projectiles by a circular Gaussian (normal) distribution, there are cases in which the dispersions in distance and in azimuth are so unequal that approximation by means of an elliptical Gaussian distribution is a significant improvement. This memorandum evaluates the probability that a missile will land within a circle if it is aimed at the center and subjected to an elliptical Gaussian impact probability distribution. A table of the elliptic coverage function is provided and illustrated in graphical form. 26 pp. Illus.

Ø • RM-2767 (AD 257937). Spare parts inventories for NATO. Horst Mendershausen. 5-23-61. Unclassified.

An examination of several features needed by jointly financed spare parts inventories operated for weapon systems common to NATO countries. The study attempts to show the important problems that such an undertaking would face and suggests solutions to them. It is urged that the participating countries should build, in the NATO Supply Center, joint inventories for prompt service, and should commit themselves to the full use of these inventories. For achieving best results, materiel should be available to the users on requisition, certain procurement functions should be delegated by the countries, weapon system partnerships should be developed, both purposes and inventory ranges should be clearly defined, and costs should be shared on a planned and equitable basis. 53 pp.

RM-2768 (AD 257973). The Indonesian eight-year over-all development plan. G. J. Pauker. 6-9-61. Unclassified.

A discussion of the development plan that now represents the officially sanctioned policy of the Indonesian government. The A projects outlined, which are primarily concerned with the improvement of the living conditions of the Indonesian population, are not excessively ambitious and will have to be carried out in some way, otherwise the situation in Indonesia will deteriorate drastically in the years ahead. The B projects imply that the financing of development is not secured. Those areas most important among the A projects are research, rice production, fertilizers, textiles, antibiotics, land and air transport, shipping, and telecommunications. 42 pp. Also published as P-2313.

Ø • RM-2771 (AD 267434). Military force and Soviet goals. H. S. Dinerstein. 6-2-61. Unclassified.

An examination of the methods whereby the Soviets use military power to further political ends. The methods used are (1) demonstrations of the existence of military power; (2) threats to use force under circumstances vaguely defined; and (3) the sale of conventional weapons to selected countries. Soviet possession of nuclear weapons is used to intimidate our NATO allies into considering exclusion of nuclear weapons from their territories as a means of reducing the danger of total destruction. In this connection, however, Berlin poses a dilemma for the Soviets (namely, pressure on Berlin enhances the attractiveness of NATO protection, while relative passivity encourages resistance to Soviet demands). As for the sale of weapons, in every instance the purchaser could be expected to use them militarily or politically against a member of NATO, CENTO, or SEATO. Aid to emergent nations is considered a blow to Western imperialism, and therefore a means of weakening capitalism and of fostering socialism and ultimately communism. It is concluded that

nuclear weapons have not cancelled themselves out. On the contrary, even without war, it is plain that weapons of all kinds will continue to play an important role in international life. 29 pp. Published in *Orbis*, Winter 1962.

- **RM-2772 (AD 260560). A variational approach to differential games.** L. D. Berkovitz. 6-30-61. Unclassified.

An investigation, derived from the calculus of variations, of a class of differential games having pure strategy solutions. These games are related to two Bolza problems with differential inequalities as added side constraints. Necessary conditions that must hold along an optimal path are derived from the theory of the related Bolza problems. These conditions are (1) a multiplier rule, together with transversality conditions and jump conditions; (2) a local min-max condition that is related to the Weierstrass condition; and (3) an analogue of the Clebsch condition. The continuity and differentiability properties of the value of the game are derived. It is shown that, wherever the value is differentiable, it satisfies an analogue of the Hamilton-Jacobi equation. Sufficient conditions are given in terms of the notion of a field and of a local min-max condition. 90 pp. Also published as P-2205. See also RM-3012-PR.

- RM-2776-AEC. The Mössbauer effect.** S. A. Moszkowski. December 1961. Unclassified.

A discussion of Mössbauer's discovery of recoil-free gamma ray resonance absorption. Highlights of this effect are examined, as well as its essential features and applications. In particular, the memorandum considers (1) the problems of resonance absorption and the effects of nuclear recoil, (2) the way in which the cross section for recoil-free resonance absorption of gamma rays is related to the lifetime of the nuclear state, (3) the problem of Doppler shift, (4) some theoretical considerations, (5) the gravitational redshift, and (6) other applications. 50 pp. Illus.

- **RM-2786-PR. Cost-Quantity Calculator.** J. W. Noah and R. W. Smith. January 1962. Unclassified.

An explanatory guide to a pocket-sized Cost-Quantity Calculator (enclosed with the study) for constructing and interpreting "learning" curves displaying cost-quantity relationships. The authors distinguish between the two most commonly used forms of linear-function learning curves—the cumulative average curve and the individual unit curve. Values are also supplied for the functions for selected slopes and quantities. Examples are provided illustrating the use of the calculator and associated tables. 30 pp. Illus.

- **RM-2798-AEC. The strength of underground cavities of spherical and spheroidal geometry.** J. M. Green. October 1961. Unclassified.

Expressions for the static-stress distribution over the surface of a degenerate prolate spheroidal cavity which is subjected to a given internal pressure and a given lithostatic loading at infinity. The hoop stress is evaluated at the apex of the spheroidal cavity and is compared with the hoop stress at the corresponding point of a spherical cavity, which is subjected to the same loading. Both cavities are presumed to fail when the hoop stress ceases to be compressive. It is shown that the maximum internal pressure which may be sustained by each of the cavities depends on the Poisson ratio. For certain values of the Poisson ratio, the spherical cavity can actually contain larger internal pressures than the spheroidal cavity, in spite of the fact that when the cavities are "empty," the spheroidal cavity has a hoop stress at its apex which is more compressive than that of the spherical cavity. 34 pp. Illus.

- RM-2799-PR (AD 266129). Soviet cybernetics and computer sciences, 1960.** E. A. Feigenbaum. October 1961. Unclassified.

A description of the author's experiences as a delegate to the International Congress on Automatic Control held at Moscow, June 27–July 7, 1960. The memorandum discusses (1) certain aspects of the conference; (2) some Soviet research projects in artificial intelligence and biocybernetics; and (3) general Soviet attitudes, techniques, and directions in the cybernetic and computer-related sciences. It is concluded that Soviet research in the computer sciences lags behind Western developments, but that the gap is neither large nor based on a lack of understanding of fundamental principles. The Soviets will progress rapidly if and when priority, in terms of accessibility to computing machines, is given to their research. 77 pp. Illus. See also RM-2541. Published in the *IRE Transactions on Electronic Computers*, December 1961.

Ø RM-2800-PR (AD 267167). Economics Department publications, 1948-1961: an author index of the open literature, with abstracts. H. E. Porch. October 1961. Unclassified.

The title of this memorandum adequately describes its contents. 122 pp.

- RM-2801-PR (AD 268643). Ecological problems and postwar recuperation: a preliminary survey from the civil defense viewpoint. H. H. Mitchell, M.D. August 1961. Unclassified.

A discussion of the disruption, which may occur following a nuclear attack, by fire and nuclear radiation, of the biological community. The direct result of the widespread fires will be the destruction of crops, timber, livestock, and wild life. The indirect result may be equally serious: The destruction of ground cover might permit erosion that would turn large areas of the country into uninhabitable "dust bowls." The effects of radiation are much less understood. They could include a change in the balance of life forms favoring harmful creatures such as grasshoppers or rats, or the lethal concentration of radioactive substances by plants and animals. While studies concerned with the disposal of radioactive waste will be useful, a great deal of specific research must be done before the ecological effects of radiation can be predicted with certainty. 44 pp. Illus.

- Ø ● RM-2807-PR (AD 264422). A parametric study of certain low-molecular-weight compounds as nuclear rocket propellants—V: methane. F. J. Krieger. August 1961. Unclassified.

The fifth in a series of studies on hydrogen compounds as nuclear rocket propellants. Although this research memorandum discusses methane, the series includes reports on hydrogen, ammonia, water, lithium hydride, and (planned) methanol. The author attempts to find a chemical rocket propellant with some of the advantages of hydrogen but with few of its disadvantages. Thus far, results of the computations show that although molecular hydrogen is superior in specific impulse, certain hydrogen compounds have physical properties that may eliminate some of the great logistic and design-application problems that hydrogen presents. 73 pp. Illus. See also RM-2400 through RM-2403.

- RM-2810-PR (AD 266149). Rules for planned replacement of aircraft and missile parts. M. Kamins and J. J. McCall, Jr. November 1961. Unclassified.

A study of replacement policies for aircraft and missile parts, showing how the appropriate replacement policy for any part depends on its failure characteristics and on the penalty associated with a failure in service. For planned replacement of a particular part to be worth while (i.e., replacement before failure), two necessary conditions must be satisfied. The part must display a wear-out characteristic (a failure rate that increases with time), and there must be some penalty for a failure in service (the cost of a failure in service must be greater than the cost of a planned replacement). The study discusses how an optimum planned replacement policy can be developed and presents empirical results for parts whose failure characteristics can be described by some of the better-known probability distributions of mathematical statistics. It also shows the savings that can result from following such an optimal policy instead of a replace-at-failure-only policy. 103 pp. Illus. See also P-2563.

- RM-2810-PR (abr.). Rules for planned replacement of aircraft and missile parts. M. Kamins. March 1962. Unclassified.

An abridgment of RM-2810-PR. 32 pp. Illus.

- Ø ● RM-2812-PR (AD 269106). The Soviet oil offensive and inter-block economic competition. Harold Lubell. December 1961. Unclassified.

A study that analyzes available data on Soviet oil production and exports, and relates these data to the broader East-West economic struggle. The Soviet oil export drive illustrates three aspects of inter-bloc rivalry: competition in economic and technological achievement, competition for influence, and competition for markets. In each the Soviet oil offensive has achieved considerable success. The author assesses the effects of Soviet oil exports on the West as both consumer and producer of oil. As consumer, the West can gain from lower prices but runs the risk of a less reliable oil supply. Measures are discussed for reducing this risk by ensuring the availability of alternative supplies. 93 pp. Tables.

- Ø • RM-2813-PR (AD 263628). The decomposition algorithm for linear programming: notes on linear programming and extensions—part 57. G. B. Dantzig and P. S. Wolfe. September 1961. Unclassified.

A procedure for the efficient computational solution of linear programs having a certain structural property characteristic of a large class of problems of practical interest. This property makes possible the decomposition of the problem into a sequence of small linear programs whose iterated solutions solve the given problem through a generalization of the simplex method for linear programming. 33 pp. Illus. A revision of P-1544. Published in *Econometrica*, October 1961.

- Ø • RM-2818-PR (AD 264424). The hypersonic trail in the expansion-conduction region. P. S. Lykoudis. September 1961. Unclassified.

A procedure for calculating the cooling process in the wake behind a blunt object entering the earth's atmosphere. In certain important cases, this method gives greater accuracy than the procedure usually used. For small bodies of the order of 1 cm, often used to simulate re-entry bodies in a ballistic range, the difference between the two methods may be large when high simulated altitudes are considered. 20 pp. Illus. A refinement of RM-2682-1-PR.

- Ø • RM-2820-PR (AD 264604). Classical electron theory from a modern standpoint. S. R. Coleman. September 1961. Unclassified.

The development, from first principles, of the theory of a charged point particle interacting classically with the electromagnetic field. The formalism is constructed to reveal the underlying physics and to stress the similarity between the classical theory and the corresponding quantum theory. Such points are discussed as the electromagnetic self-energy, the relativistic radiation-reaction equation, the occurrence and removal of runaway modes, the radiation from a uniformly accelerated charge, and the relation between Maxwell's electrodynamics and the action-at-a-distance theory of Wheeler and Feynman. 47 pp. Illus.

RM-2824-FF. Transportation for future urban communities: a study prospectus.
8-10-61. Unclassified.

An outline of how RAND expects to proceed with its study of urban transportation. Techniques used by many major metropolitan areas in urban analysis are described. Useful contributions RAND might make are suggested, and the gross characteristics of a model designed to meet some suggested criteria for further research are examined. A framework for the RAND research program on urban transportation is discussed. The total effort is then divided into a number of studies which not only will make an important independent contribution to urban analysis, but also will allow an over-all integration of results. 53 pp.

- Ø • RM-2825-PR (AD 269113). Solar-flare radiation and manned space flight. D. J. Dugas. November 1961. Unclassified.

A summary of present knowledge of solar-flare radiation, one of the major hazards to manned space flight. Areas are listed in which more experimental data are needed to accurately compute the shielding requirements for space vehicles. Some frequently quoted estimates of the weight of adequate shielding have been prohibitively high. However, this memorandum shows that these estimates may be three to six times larger than necessary. It is concluded that appropriately designed experiments in the space research program can help to eliminate the ambiguities in shielding calculations. 30 pp. Illus.

- RM-2835-PR. Operational and human factors in planning automated man-machine checkout systems. S. I. Firstman and N. Jordan. April 1962. Unclassified.

An attempt to improve the planning and design of automated checkout equipment for military systems. The study considers the capabilities and limitations of present automatic checkout equipment and of operator-technicians. It also examines the interrelationships of the automatic checkout equipment with the environments it affects—the prime equipment, ground system, and personnel involved. 67 pp.

RM-2844-PR. Postattack damage assessment: a conceptual analysis. B. F. Massell and S. G. Winter, Jr. November 1961. Unclassified.

A study dealing with damage assessment for postattack strategic and civil defense decisionmaking and for decisions relating to survival and economic recovery following a thermonuclear war. The objectives of a damage assessment system are analyzed in terms of the relevance of the information provided by the system to various strategic and civil defense decisions. The problems of assuring the survival of the system and its effective integration with the decision process are also discussed. The conclusions emphasize (1) the possibility that the enemy may intentionally target the system and (2) the importance of pre-attack research in the area of strategic and civil defense decision-making. 58 pp.

RM-2852-PR (AD 266142). Information on the 1961 Minsk Conference on Heat and Mass Transfer with Phase and Chemical Conversions. J. B. Gazley and C. Gazley, Jr. November 1961. Unclassified.

A collection of abstracts of papers presented at the Conference on Heat and Mass Transfer with Phase and Chemical Conversions, held at Minsk, B.S.S.R., June 5-9, 1961. These unedited abstracts, translated by the Russians, are being made available so that specialists in these fields can be aware of the conference and of the availability of some of the papers presented. 67 pp.

Ø • **RM-2858-PR (AD 272828). The nature of research goals: some necessary definitions.** E. G. Mesthene and S. MacClintock. January 1962. Unclassified.

An examination of the distinguishing features of three kinds of research goals encountered in R&D programs. Prospective end items are the proper goals of development, and purely intellectual goals govern academic research. In conducting research, industrial and governmental agencies whose missions are other than simply scientific have the problem of defining "useful research goals" that will at once allow the freedom of inquiry necessary to good research and still offer a reasonable probability that the completed research will be useful to the sponsoring organization. The problem, in short, is to determine the exact nature of the relevance of research to mission that must be embodied in useful research goals. 32 pp.

RM-2859-PR. New directions of research in the theory of differential equations. R. E. Bellman. October 1961. Unclassified.

A discussion of the impact of novel mathematical ideas—such as those related to control processes, neutron physics, and digital computers—on the classical domain of differential equations. 29 pp. Presented before the International Symposium on Nonlinear Differential Equations and Nonlinear Mechanics at the Air Force Academy, Colorado Springs, Colorado, July 31-August 4, 1961, and published in the proceedings of the Symposium.

RM-2860-PR (AD 267302). Values of large games—V: an 18-person market game. L. S. Shapley. November 1961. Unclassified.

Part of a continuing effort to extend applications of n -person game theory. This memorandum applies the principles of modern game theory to a set of imaginary horse-market transactions described in Böhm-Bawerk's *Positive Theory of Capital* (1891). Value solutions are obtained by Monte Carlo techniques for this 18-person market game and for a 16-person variant. 28 pp. Illus. Presented before the Conference on Recent Advances in Game Theory at Princeton, New Jersey, October 4, 1961.

Ø • **RM-2869-PR (AD 270859). Limiting distributions for critical multitype branching processes with discrete time.** T. W. Mullikin. December 1961. Unclassified.

A contribution to the basic theory of branching processes, which deals with the multiplication of objects subject to the laws of chance. The theory has been applied in the past to cosmic ray showers, nuclear reactions, and the multiplication of cells. This memorandum describes the probability law governing the descendants of a single object after many generations, if on the average an object has just one surviving child. These results could be useful in the study of controlled nuclear reactions or in the mathematical treatment of such biological phenomena as bacterial fission. 55 pp. See also RM-2917-PR.

- **RM-2878-FF. A first approximation to a RAND model for study of urban transportation.** J. F. Kain and J. R. Meyer. November 1961. Unclassified.

The development of a generalized model of an urban complex for studying the intricate interrelationships between transportation and the spatial organization of economic activities. While the behavioral relationships suggested in this first approximation fall short of constituting a full "structural model" of urban economic and social processes, they do provide a systematic framework for collecting some of the information needed to construct more complete and basic models. 57 pp. Illus.

- Ø ● **RM-2879-PR (AD 274594). The gravitational concentration of particulate matter in the space near the earth.** S. H. Dole. April 1962. Unclassified.

A computational approach to the problem of explaining the observed concentration of particles (meteoroids) in the space near the earth. This concentration of particles can be attributed entirely to the earth's gravitational attraction. Experimental runs on the IBM 7090 computer show two general classes of particles: those destined to impact on the earth, and those moving in loops around the earth, making one or more approaches before returning to purely heliocentric orbits. 59 pp. Illus.

- Ø ● **RM-2881-PR (AD 273329). Some methods for establishing interplanetary transfer orbits.** L. N. Rowell. March 1962. Unclassified.

A presentation of four basic methods for establishing heliocentric interplanetary transfer orbits. These methods and their variations can be used to establish orbits having specified transfer angles, transfer times, hyperbolic excess velocities, or heliocentric departure velocities. Each method consists of a step-by-step computation procedure that uses the equations of two-body motion and appropriate trigonometric relations to establish the desired transfer orbit. 72 pp. Illus.

- **RM-2883-PR. On systems of linear inequalities in Hermitian matrix variables.** R. E. Bellman and K. Fan. March 1962. Unclassified.

A study concerned with systems of linear inequalities involving complex variables. In this general context, the authors determine conditions for the existence of solutions and investigate extreme values of pertinent linear functions. Systems of linear inequalities involving real variables are of frequent occurrence in the linear-programming approach to military and industrial problems. 28 pp.

- **RM-2887-PR. Minimum-weight design for moving loads.** O. A. Gross and W. Prager. January 1962. Unclassified.

A derivation of a mathematical model that describes the minimum-weight design of a horizontal beam under an invariable, concentrated, vertical load moving slowly from one end to the other. Beams of this type, although seemingly impractical in earthbound structures, may have potential applications in a weightless environment such as that of a space station. 23 pp. Illus.

- Ø ● **RM-2888-PR (AD 268491). Variational methods in problems of control and programming.** L. D. Berkovitz. December 1961. Unclassified.

A study that shows a fairly general control problem, or programming problem, with constraints can be reduced to a special type of classical Bolza problem in the calculus of variations. Necessary conditions from the Bolza problem are translated into necessary conditions for optimal control. It is seen from these conditions that Pontryagin's maximum principle is a translation of the usual Weierstrass condition, and is applicable to a wider class of problems than that considered by Pontryagin. The differentiability and continuity properties of the value of the control are established under reasonable hypotheses on the synthesis, and it is shown that the value satisfies the Hamilton-Jacobi equation. As a consequence, a rigorous proof of a functional equation of Bellman is obtained that is valid for a much wider class of problems than heretofore considered. A sufficiency theorem for the synthesis of control is also given. 53 pp. Also published as P-2306.

- RM-2891-PR. On the numerical solution of a differential-difference equation arising in analytic number theory.** R. E. Bellman and B. Kotkin. November 1961. Rev. February 1962. Unclassified.

Numerical procedures for solving a class of differential-difference equations requiring high precision over a wide range of the independent variable. Equations of this kind are an important tool in such applied problems as feedback control. 10 pp. Tables.

- Ø • RM-2896-PR (AD 274181). Widths and heights of (0,1)-matrices. D. R. Fulkerson and H. J. Ryser. March 1962. Unclassified.

Part of a broader investigation concerned with combinatorial problems, which have applications to communication networks, switching circuits, and error-detecting and error-correcting codes. A number of these combinatorial problems can be formulated in terms of matrices made up of columns of zeros and ones. In this memorandum, a formula for the α -width of such a matrix is determined. 42 pp. See also RM-2897-PR and RM-2898-PR.

- Ø • RM-2897-PR (AD 274836). Multiplicities and minimal widths for (0,1)-matrices. D. R. Fulkerson and H. J. Ryser. March 1962. Unclassified.

An extension to RM-2896-PR, *Widths and Heights of (0,1)-Matrices*. This earlier study introduces the notion of the α -width of a (0,1)-matrix and obtains a formula for the minimal α -width taken over the class of all (0,1)-matrices having specified row and column sums. This memorandum presents a simple construction that produces a matrix having the property that its α -widths are minimal for all α . 28 pp. See also RM-2898-PR.

- Ø • RM-2898-PR (AD 274339). Width sequences for special classes of (0,1)-matrices. D. R. Fulkerson and H. J. Ryser. March 1962. Unclassified.

A continued study of a number of combinatorial problems which can be formulated in terms of matrices made up of columns of zeros and ones. This memorandum emphasizes certain classes of incidence matrices that have special combinatorial significance for applications. Several theorems are proved concerning the width sequence for a matrix in a particular class. Insofar as possible, these results are used to obtain information concerning the maximal width sequence for the class. 52 pp. See also RM-2896-PR and RM-2897-PR.

- RM-2899-AEC. Quasi-classical theory of electron correlations in atoms. D. F. DuBois and M. G. Kivelson. February 1962. Unclassified.

A discussion of the quasi-classical limit of many particle perturbation theory for electrons moving in the coulomb potential of the nucleus. The problem is analyzed using Green's function formulation of many particle physics. When corrections involving the gradient of the self-consistent potential are neglected, the results agree to all orders in the interaction strength with the procedure of Lewis for including correlation corrections in the Thomas-Fermi model. The disagreement between the work of Lewis and the recent work of Baraff is shown to be due to the latter's neglect of anomalous contributions to the perturbation theory. These contributions arise because the local Fermi momentum is a function of the interaction strength. The calculation of inhomogeneity corrections is also considered. 53 pp. Illus.

- Ø • RM-2906-PR (AD 270860). Operators commuting with translation by one—part II: differential operators with periodic coefficients. D. C. McGarvey. January 1962. Unclassified.

An extension of the theory of differential equations and linear operators, both of which have many applications to engineering and mathematical physics. This memorandum studies representation of operators used to employ perturbation techniques. These techniques were heretofore applicable only to operators with compact resolvents and to nonself adjoint differential operators with periodic coefficients on $L_2(-\infty, \infty)$. Conditions are given on the coefficients of these operators that ensure that they be spectral (completely reducible) even though they have continuous spectrum. 148 pp. Illus. For Part I, see P-2232.

- RM-2907-RC. A mathematical model of drug distribution and the solution of differential-difference equations. Bella Kotkin. January 1962. Unclassified.

Consideration of a mathematical model of drug distribution to study the time course of the concentration of a drug injected into the body and of the concentration of the compounds formed in the various organs. This leads to a system of differential-difference equations which arise from the time delays inherent in the physical process of the recirculating blood. The solution of such a system presents computational difficulties not encountered in ordinary differential equations, particularly in its demand on machine storage. The author describes some digital computer parameter experiments designed to study a two-organ model as a guide to the biologist in selecting drugs and injection procedures for optimal effect. A new method for the computational solution of differential-difference equations is suggested. 31 pp. Illus.

RM-2912-PR. Values of games with infinitely many players. L. S. Shapley. December 1961. Unclassified.

Part of RAND's continuing study of the underlying principles of mass competition. An account is presented of the power structure of voting games having a denumerable infinity of players. Special attention is given to the class of binary games in which each player has twice as much voting strength as the next. This research may result in mathematical tools that will help in predicting the behavior of large groups of competing participants common in political and economic life. 15 pp. Illus. Presented at the Conference on Recent Advances in Game Theory at Princeton, New Jersey, October 4-6, 1961.

• **RM-2914-PR. The Labour Party and unilateralism.** H. A. DeWeerd. December 1961. Rev. February 1962. Unclassified.

A study concerned with the effort, in 1960 and 1961, of the British unilateral nuclear disarmament movement to capture control of the Labour Party. The author shows why this effort failed and indicates that, as a result of this failure, the radical wing of the unilateralist movement now intends to achieve its objective by direct attacks on the government itself. 25 pp. See also P-2390.

ø • **RM-2915-PR (AD 270125). The titanium decade.** E. G. Mesthene. January 1962. Unclassified.

A discussion of the titanium development program, which illustrates inefficiencies inherent in government-industry contractual arrangements aimed at rapid advances in basic technology. More than half the total cost of the program to the government is the result of subsidizing the creation of a titanium metal industry. It is argued that such government programs can be more efficient in the future (1) if they recognize more specifically and are aimed more directly at the technological objective, and (2) if the contracts with industry contain more direct rewards for research and development work, rather than indirect rewards in the form of production orders. 21 pp.

ø • **RM-2916-PR (AD 268941). Research procedures in machine translation.** D. G. Hays. December 1961. Unclassified.

A discussion of the problems encountered in linguistic research in support of machine translation and other computer systems that use ordinary text as input. Solutions to these problems are also described. Some solutions are drawn from RAND work, and others from the literature. Some are tested, and some are newly proposed. 62 pp. Illus. Presented before the American Documentation Institute at Los Angeles, California, December 7, 1961.

ø • **RM-2917-PR (AD 270639). Estimates of critical dimensions of spherical and slab reactors.** T. W. Mullikin. January 1962. Unclassified.

Estimates for certain eigenvalues of a linear operator known as the "truncated Hopf operator." These eigenvalues are of value in studying the transfer of radiation and in estimating critical dimensions of certain slab and spherical reactors. 32 pp. Tables. See also RM-2869-PR.

RM-2924-PR. Some aspects of quasilinearization. R. E. Kalaba. December 1961. Unclassified.

Part of RAND's continuing study of means for exploiting the capabilities of modern computing machines in solving problems of technology and physics. When first stated mathematically, many problems in physics and technology are too difficult to be handled directly by a computing machine. This is particularly true of a number of problems in mathematical physics and in automatic control of a kind termed nonlinear boundary value problems. This memorandum discusses the analytical aspects of such problems, as well as a very efficient computational procedure that permits full use of digital computing machines in the resolution of such problems. 28 pp. Tables. Presented before the International Symposium on Nonlinear Differential Equations and Nonlinear Mechanics, held at the Air Force Academy, Colorado Springs, Colorado, July 31-August 4, 1961.

ø • **RM-2930-PR (AD 269712). An adiabatic-isothermal nozzle.** V. F. Stepanchuk. Trans. by J. B. Gazley. December 1961. Unclassified.

A translation of a Russian paper appearing in *Inzhenerno-Fizicheskii Zhurnal*. This account presents a method for the nozzle calculation for a chemically active flow at a constant static temperature. Such a flow can be obtained with an adiabatic-isothermal nozzle, which can be calculated and designed on the basis of certain relationships by the method given. 13 pp.

- Ø • RM-2931-PR (AD 270126). The structure of a shock wave in air taking account of the kinetics of chemical reactions. N. M. Kuznetsov. Trans. by J. B. Gazley. January 1962. Unclassified.

A translation of a Russian article appearing in the September, 1960, issue of *Inzhenerno-Fizicheskii Zhurnal*. Applications are cited for the practical use of a formula for solving the problem of temperature distribution and the concentrations of the components of dissociating air in the nonequilibrium region beyond the steep leading edge of a shock wave in rarefied air. The study also analyzes the problems of the dissociation of oxygen and nitrogen, the dependence of the temperature in front of the wave on the velocity of the wave, and the density of the gas. 20 pp. Illus.

- Ø • RM-2932-PR (AD 270232). Concerning a certain effect in the field of meteor aerodynamics. K. P. Staniukovich. Trans. by J. B. Gazley. January 1962. Unclassified.

A translation of a Russian article appearing in *Akademiia Nauk SSSR. Otdelenie Tekhnicheskikh Nauk. Izvestia: Mekhanika i Mashinostroenie*, Issue 5, 1960. The study analyzes meteoric ablation resulting in expressions for the variation of mass and velocity during entry into the atmosphere. The results allow the use of meteor data to deduce the properties of the upper atmosphere. 16 pp.

- RM-2937-PR. Optimal and nearly optimal policies for a class of adaptive control processes. L. D. Brown. March 1962. Unclassified.

A study concerned with the problem of finding optimal and nearly optimal policies for several variants of a general adaptive control process. The variants discussed are closely related in form. They differ only with respect to the type of return information and the objectives of the policy adopted by the observer. For each of these three variants, the optimal policy is particularly easy to compute when the known a priori distribution $G(\phi)$ is symmetric. When the known distribution $G(\phi)$ is not symmetric, the optimal policy can be approximated by the policy that is optimal for symmetric distributions. Alternatively, the distribution itself can be approximated by another distribution for which the optimal policy can easily be computed. 53 pp. Illus.

- RM-2947-AEC. On the energy distribution of terms and line arrays in atomic spectra. S. A. Moszkowski. January 1962. Unclassified.

A discussion of the Coulomb interaction which leads to a splitting of the different terms belonging to the same many-electron configuration. The resulting energy distributions of terms and of line arrays for transitions between different configurations are also studied. Expressions are derived for the first two moments of the distributions, namely, the average energy shift and the mean square deviation, as a function of the number of particles. The detailed shapes of the distributions are investigated both for $(d)^n$ configurations and for a simplified two-dimensional model. 60 pp. Illus.

- Ø • RM-2951-PR (AD 269713). The effect of surface temperature variations on the polar night jet. C. B. Leovy. December 1961. Unclassified.

Part of RAND's continuing work on the problem of accurately determining the characteristics of the upper atmosphere. This memorandum examines the possibility of differential heating in the ozone layer due to differences in ground and lower troposphere temperatures as a mechanism for producing the observed stationary perturbations of the polar night jet. It is found that this mechanism is not likely to be the cause of the disturbances. 24 pp. Illus.

- Ø • RM-2952-PR (AD 270637). Economic development and postwar recuperation: a comparison of industrial priorities. B. F. Massell and C. Wolf, Jr. January 1962. Unclassified.

A comparison between industrial priorities for economic development in underdeveloped areas and for recuperation from thermonuclear war in developed countries. A theoretical discussion precedes a presentation of the similarity of industrial priorities in the two contexts. Some possible implications of these results for U.S. policy are also discussed. 34 pp. Tables.

- Ø • RM-2953-PR (AD 270127). On the effectiveness of search algorithms based on samples of controlled duration (sequential detection). U. B. Kobzarev and A. E. Basharinov. Trans. by L. E. Brennan. December 1961. Unclassified.

A translation of an article appearing in the September issue of the USSR Academy of Sciences periodical *Radiotekhnika i elektronika*. The article discusses sequential detection, which is a promising technique for extending the search range of phased-array radars (a new type of radar currently under development). In particular, search procedures are considered that use trial steps of controlled duration. Indices are defined that characterize the effectiveness of these controlled search procedures, and the influence of the capacity on these indices is estimated. 21 pp. Illus.

- RM-2956-PR. An algorithm for scaling matrices: notes on linear programming and extensions—part 58. D. R. Fulkerson and P. S. Wolfe. February 1962. Unclassified.

An algorithm for optimal "matrix scaling"—multiplying rows and columns of a rectangular matrix by different factors so as to optimize its condition. The method is expected to improve the computational solution of linear programming problems. 25 pp. See abridgment P-2363.

- Ø • RM-2957-PR (AD 274595). Linear programming in a Markov chain: notes on linear programming and extensions—part 59. G. B. Dantzig and P. S. Wolfe. April 1962. Unclassified.

A study concerned with an infinite Markov process with a finite number of states in which the transition probabilities for each stage range independently over sets that either are finite or are convex polyhedra. A finite computational procedure is given for choosing those transition probabilities which minimize appropriate functions of the resulting equilibrium probabilities. 31 pp. Table. Supersedes P-1842.

- RM-2975-PR. Military systems cost analysis (a summary lecture for the AFSC cost analysis course). G. H. Fisher. January 1962. Unclassified.

A discussion of cost analysis as it refers to the determination of the probable economic resource impact of future Air Force weapon and support systems. Five major aspects of cost analysis are stressed: understanding the problem or context in which the cost estimates are to be used, assembling the basic data, deriving cost-estimating relationships, using these relationships to make an estimate, and presenting the results. Both hardware and nonhardware system cost components are discussed, and the sensitivity of total system cost to variations in the cost and characteristics of these components is considered. 29 pp. Illus.

- Ø • RM-2978-PR (AD 272143). On the approximation of curves by line segments using dynamic programming—II. R. E. Bellman and B. Kotkin. February 1962. Unclassified.

Ways in which dynamic programming can be applied to multidimensional problems that cannot be treated easily within the limitations of present-day computers. A possible application includes the computation of ballistic-missile trajectories. 16 pp. Table.

- Ø • RM-2987-PR (AD 274684). Approximate band-pass limiter envelope distributions. W. L. Doyle, Jr., and I. S. Reed. February 1962. Unclassified.

A computation of an approximate distribution for the envelope of sine wave plus noise after passage through a wide-band filter, limiter, and narrow-band filter. As the input bandwidth to the limiter increases, it is shown that the output envelope distribution converges to the usual sine wave in noise envelope distribution, without limiting, but with a definite 1.4-db loss. First-order correction terms are supplied which make it possible to compute first-order statistics for the output envelope when the output signal-to-noise ratio is on the order of one. 28 pp. Illus.

- Ø • RM-2989-PR (AD 272144). Solution of a simple overhaul problem. J. J. McCall. February 1962. Unclassified.

A method for solving a simple overhaul problem that may be applicable to the guidance and control section of the Minuteman missile. The system considered is composed of two subsystems, one of which fails randomly while the other fails according to an aging distribution. Both subsystems are inspected periodically, and the system is shipped to a depot whenever a failure of either sub-

system is detected. Given a failure, a method is presented for determining the replacement and repair actions that should constitute an overhaul. The method also indicates the age at which an unfailed system should be overhauled. The method is designed so that system effectiveness is maximized. 24 pp. Table.

- Ø • RM-2993-PR (AD 274596). **A linear program of Prager's: notes on linear programming and extensions—part 60.** O. A. Gross. April 1962. Unclassified.

The solution of an infinite-dimensional linear-programming problem, which involves basic mathematical research. The problem, proposed by W. Prager, arose in an elasto-plastic structural-design context. 29 pp. Illus.

- RM-2998-PR. **Scabbing in rock tunnels.** K. B. Broberg. Trans. by Armas Laupa. February 1962. Unclassified.

A translation of a paper published by the Royal Swedish Fortification Administration. An extensive series of experiments is described in which high-explosive charges were detonated on the cover of small-diameter tunnel openings in rock. Experimental data are given on scabbing (spalling) and breakthrough phenomena. While not directly applicable, the memorandum may be useful in the design and construction of deep underground installations required to survive nuclear attacks. 21 pp. Illus.

- RM-3001-PR. **Poisson summation formulas for groups—1: finite groups.** R. E. Bellman. March 1962. Unclassified.

The establishment of a summation formula for finite groups. These groups are analogous in form and proof to the classical Poisson summation formula. 8 pp.

- Ø RM-3005-PR (AD 270861). **The irrelevance of the Gnome shot to decoupling.** A. L. Latter, R. Latter, and W. G. McMillan. January 1962. Unclassified.

A discussion of the misconception in the public press that the unexpectedly large signals from the recent Gnome shot somehow imply that the big hole decoupling factor should be reduced from the original estimate of 300. The Gnome shot—tamped in salt—has no relevance to the decoupling factor, which, by definition, relates the seismic signal from a tamped shot in tuff to that from a cavity shot in salt. An explanation is given of how the misconception about Gnome arises. 5 pp.

- RM-3007-PR (AD 270816). **Studies in the theory of computational algorithms—1: formalization, computability, representation, and analysis problems.** R. E. Levien. January 1962. Unclassified.

Results of research in the theory of computation for an improved understanding of the general nature of computing and computers. Formalizations of the notion of computation, algorithm, and general-purpose computer are presented. The class of entities that are computable is identified. A language for the representation of algorithms is introduced, and formal techniques for the analysis of computational procedures are specified. This research is a necessary phase in the search for formal, mechanizable techniques for the design and use of general-purpose computers, such as those used in contemporary command and control systems. 272 pp. Illus.

- RM-3009-FF. **Teacher shortages and salary schedules.** J. A. Kershaw and R. N. McKean. February 1962. Unclassified.

An analysis of the relationship between teacher shortages and salary schedules in the public schools. It is shown that the problem facing the schools is not so much a shortage in the total numbers of teachers available as it is a problem of shortages of well-qualified teachers in specific subject-matter areas. What is needed is a salary schedule which recognizes the existence of the professional opportunities outside of teaching for teachers with certain subject-matter skills. A salary schedule with subject-matter pay differentials would be an effective and relatively inexpensive way of filling specific teacher shortages in the short run and of achieving, in the long run, a better balance of subject-matter specialties among teachers in training. The administrative problems attending the introduction of such a schedule are discussed, and it is concluded that they can be resolved without insuperable difficulties. 240 pp. See also RM-2473-FF. To be published by McGraw-Hill Book Company, Inc.

- **RM-3010-PR. Data description for DETAB-X (decision table, experimental).** S. L. Pollack and K. R. Wright. March 1962. Unclassified.

A description of the use of tables with COBOL (*Common Business Oriented Language*), a Department of Defense developed machine language for describing business problems. These tables are intended to help data-system designers specify their data characteristics more fully and reduce the amount of redundancy of data description presently existent. 46 pp. Illus. Presented before the Systems Group of CODASYL at Philadelphia, Pennsylvania, January 23-26, 1962.

- Ø ● **RM-3011-PR (AD 272894). Mechanisms underlying predictive behavior for an intelligent machine.** M. E. Maron. February 1962. Unclassified.

A discussion of the role of prediction as the key process underlying the function of an intelligent machine. A model of a "neuron" is presented that exhibits properties of memory and learning. The formalism of the calculus of probability permits the behavior of a neuron to be interpreted in such a way as to justify the organization of a network of such elements so that it can learn to predict. 36 pp. Illus.

- Ø ● **RM-3012-PR (AD 272145). A differential game without pure strategy solutions on an open set.** L. D. Berkovitz. February 1962. Unclassified.

An investigation concerned with the theoretical aspects of developing a satisfactory theory of differential games. The general name "differential games" is applied to conflicts in which the state of a system is influenced by choices made continuously by each of two antagonists. One player seeks to maximize a payoff while the other seeks to minimize it. Examples of differential games occur in models of tactical air warfare and in problems of interception and pursuit. 34 pp. See also RM-2772.

- RM-3014-PR (AD 272138). When to stop sampling and initiate product improvement.** J. J. McCall. February 1962. Unclassified.

A study concerned with the problem of apportioning funds allocated to weapon system improvement between cost and benefit estimates (information gathering) and actual product improvement. A rule is outlined whereby the decisionmaker, on the basis of certain subsystem characteristics, can determine when to stop gathering information and when to initiate changes to enhance weapon system performance. A technique suggested for ranking a particular subsystem depends on the subsystem's failure rate, the number of subsystems of this type in the weapon system, the cost in weapon system downtime of a subsystem failure, the maintenance cost of a subsystem failure, the initial cost of the weapon system, and the weapon system's expected service life. 22 pp. Illus.

- Ø ● **RM-3015-PR (AD 272559). A computational procedure for optimizing interplane-tary trajectories.** Y. C. Ho. February 1962. Unclassified.

A computational procedure for optimizing dynamical system trajectories by a method of successive approximations. The procedure may be applied to a large class of control problems that are described by nonlinear differential equations. The performance criterion that is minimized by the process is the weighted sum of the squares of the terminal errors in the system state variables, subject to certain constraints on the control variables. The method is applied to the optimization of a low-thrust trajectory from Earth to Mars. 36 pp. Illus.

- **RM-3021-PR. Optimal capacity scheduling.** A. F. Veinott, Jr., and H. M. Wagner. February 1962. Unclassified.

A presentation of methods for solving a class of capacity scheduling problems. The specific problem considered is that of contracting for warehousing capacity. A contract must be let for warehouse capacity over n time periods, in which the minimum capacity to be provided is specified in each time period. Savings can be achieved by longer-term leasing arrangements or by contracting at favorable periods of time, even though this creates idle capacity at certain time periods. The study then shows that the minimum cost solution obtained can be extended to other important logistics and management problems (e.g., equipment replacement and overhaul, labor force planning, and multi-commodity warehouse-storage decisions). 81 pp. Illus.

- Ø ● **RM-3024-PR (AD 272429). Error burst chains in data transmission.** Pierre Mertz. February 1962. Unclassified.

A description of error bursts in data transmission with hyperbolic, rather than classical, Poisson laws. It is shown that within an error-burst chain the distribution is Poisson, but that the long-time

distribution is hyperbolic. An estimate is also given of the longest expected chains in tests of given durations. 37 pp. Illus.

- RM-3026-PR. On the nonconvergence of fictitious play. L. S. Shapley. March 1962. Unclassified.

An examination of the "method of fictitious play," generally considered a useful tool in game-theoretic analysis. This method, which can be applied to any finite game, imitates a multistage learning process. A counterexample is given to disprove the long-standing conjecture that the method will solve any noncooperative game. It is concluded that the method is of limited reliability in analyzing nonzero-sum games. 14 pp. Illus.

- RM-3027-PR. A complete solution of the X and Y equations of Chandrasekhar. T. W. Mullikin. March 1962. Unclassified.

Treatment of certain nonlinear integral equations that are used in studying the transfer of radiation through scattering media. Chandrasekhar recognizes that in some cases these equations do not have a unique solution. This memorandum analyzes a complete criterion for uniqueness and solutions for nonunique cases. The author shows that nonuniqueness is much more prevalent than heretofore presumed. This necessitates care in numerical computations, as well as in the use of the results of any such computations. 28 pp.

- ø RM-3031-PR (AD 274598). On a mechanical interpretation of the null geodesics in static Einstein-Riemann spaces. T. Y. Thomas and D. G. B. Edelen. March 1962. Unclassified.

A discussion of the Einstein general theory of relativity as the most widely accepted theory for describing gravitational phenomena. However, this theory is not as simple as might be desired, and a full understanding of its implications is not easily acquired. This memorandum gives those intuitively elusive objects, "null geodesics," a mechanical interpretation which may help to explain them in terms of more concrete quantities. The study shows that the normal trajectories to any moving, two-dimensional surface which carries a mechanical disturbance through a material body are the projections into that body of light rays in an Einstein-Riemann space whose local velocity of light is equal to the normal velocity of the surface through the material body at corresponding points. 22 pp.

- RM-3039-PR. On the characterization of contemporaneous and Born rigid motions and the question of their equivalence. D. G. B. Edelen and T. Y. Thomas. April 1962. Unclassified.

A study of the characterizations under which regions of a four-dimensional Einstein-Riemann space admit contemporaneous and Born rigid motions. These characterizations are given in terms of the existence or nonexistence of coordinate systems for which the fundamental metric tensor exhibits specifically-stated structure and dependence on the coordinates involved. These results show that contemporaneous rigid motions are a proper subset of Born rigid motions. Conditions for the reduction of the former to the latter are given directly in terms of the components of the fundamental metric tensor. The results indicate that neither definition of rigidity is immune to criticism. 12 pp.

- ø RM-3049-PR (AD 273516). Essential factors of thunderstorm forecasting. J. D. Sartor. March 1962. Unclassified.

The demonstration of a method for formulating a mathematical relationship between the occurrence of thunderstorms and several essential prior conditions. A winnowing of 24 thunderstorm-forecasting parameters leads to the isolation of five essential factors and an expression demonstrating their possible relationship to thunderstorms. 30 pp. Tables.

- ø RM-3050-PR (AD 273155). Collision damping of plasma oscillations. D. F. DuBois, V. Gilinsky, and M. G. Kivelson. March 1962. Unclassified.

A memorandum dealing with the absorption of longitudinal electromagnetic waves in a plasma. The results show that collision damping dominates the "collisionless" Landau damping for long wavelengths in high-temperature low-density plasmas. 10 pp. Illus.

- **RM-3053-PR (AD 272847). Recent Soviet advances in aerospace technology.** F. J. Krieger, January 1962. Unclassified.

Part of a broader investigation concerned with the development of Soviet astronautics and based primarily on material gleaned from Soviet literature. The Soviet aerospace program has been developing in three well-defined, although interrelated, phases—the earth-orbital, the lunar, and the interplanetary. All phases are aimed at eventual manned interplanetary travel. More powerful propulsion systems are being developed by the Soviets for launching space vehicles than heretofore used by combining rocket motors with special-purpose turbojet and ramjet engines. 32 pp. Illus. Presented before the National Tracking and Command of Aerospace Vehicles Symposium at San Francisco, California, February 19–21, 1962.

- **RM-3056-PR. On the maximum transform and semigroups of transformations.** R. E. Bellman and W. Karush, March 1962. Unclassified.

A study showing how the mathematical technique of the maximum transform can often be applied effectively to the problem of determining the maximum or minimum value of a function subject to prescribed constraints. 12 pp.

- **RM-3063-PR. Functional equations in the theory of dynamic programming—XII: an application of the maximum transform.** R. E. Bellman and W. Karush, March 1962. Unclassified.

An application of the mathematical technique of maximum transform to the solution of functional equations occurring in the theory of dynamic programming. 12 pp.

- **RM-3066-PR. Determining preferred management techniques in new systems through game-simulation.** M. A. Geisler and W. A. Steger, April 1962. Unclassified.

A discussion of the role of humans in management systems and of the usefulness of the game-simulation technique in studying such systems. For example, in complex systems humans are shown to play an assortment of roles that are not well enough formulated to be represented with sufficient mathematical accuracy for study by all-computer simulations. The memorandum indicates that although game-simulation techniques have many of the necessary characteristics for satisfying the requirements of a management system design and evaluation method, they also have many limitations. This investigation is largely based on experiences with Laboratory Problem II, a game-simulation study of the management system required by an ICBM wing to achieve a high percentage of missiles on alert under operational conditions. 30 pp.

- **RM-3075-PR (AD 274597). Expected critical path lengths in PERT networks.** D. R. Fulkerson, March 1962. Unclassified.

A description of a computational method that yields a fairly good approximation to the expected duration time of a project whose individual job times are random variables. The study is intended primarily for application in project duration and cost network models such as PERT, but may also be applicable to communication networks whose components are subject to random delay times. 26 pp. Illus.

- **RM-3077-PR. Some remarks on scientific achievement in Communist China.** G. B. W. Young, March 1962. Unclassified.

A study presented before the Science Sessions of the Association for Asian Studies at Boston, Massachusetts, April 2–4, 1962. China hopes to approach, in many important fields of science and technology, the most advanced levels attained in the world by 1967. This memorandum reviews the scientific progress in contemporary China by focusing attention on the science budget and the command decision of 1958. The review suggests that Communist China will only have firmly established a base for such an attainment, but it can be quite an impressive base. However, by maximum concentration of effort, China can perform a limited number of scientific feats by 1967, especially those that can be performed merely with the support of a high-level state of the art in the unsophisticated technologies, and with the technical personnel trained since 1958 in the institutes of the China Academy of Science. 28 pp. Tables.

- Ø● **RM-3080-PR. The analytic signal representation of modulated waveforms.** Edward Bedrosian. March 1962. Unclassified.

The presentation of a rather general and mathematically convenient model for analyzing various types of signal modulation. From an examination of the various cases which the model embraces, a new type of modulation is discovered. This single side-band form of phase or frequency modulation retains many of the advantages of existing frequency modulation while reducing the bandwidth needed. 30 pp. Illus.

- **RM-3083-PR. Some questions concerning difference approximations to partial differential equations.** R. E. Bellman. April 1962. Unclassified.

A discussion of the solution of the partial differential equations of applied mathematics on automatic digital computing machines through approximations by difference equations. The memorandum investigates the determination of discrete approximations that manifestly possess properties (e.g., boundedness and positivity) of the given differential operator. 12 pp.

- Ø● **RM-3084-PR (AD 275312). Polynomial approximation: a new computational technique in dynamic programming—I: allocation processes.** R. E. Bellman, R. E. Kalaba, and B. Kotkin. April 1962. Unclassified.

The application of the computational technique of polynomial approximation to problems in dynamic programming. The theoretical applicability of orthogonal polynomials is first discussed and then applied to one- and two-dimensional allocation problems. Numerical results obtained from FORTRAN programs involving Legendre polynomials are presented. 32 pp. Tables.

- **RM-3090-PR. Interpolation and extrapolation of stationary random sequences.** A. N. Kolmogorov. Trans. by W. L. Doyle, Jr., and I. Selin. April 1962. Unclassified.

The establishment of spectral conditions for the possibility of extrapolating and interpolating stationary random sequences by a sufficiently large number of terms with arbitrary, given accuracy. 17 pp.

- **RM-3091-PR. On the structure of stationary random functions.** K. Karhunen. Trans. by Ivan Selin. April 1962. Unclassified.

A translation from the German of an article appearing in *Archives for Mathematics*, Vol. I, No. 13, 1949. The paper deals with the representation of stationary stochastic processes in terms of simple functions of time. Necessary and sufficient conditions are given for the validity of such representations, and applications to the theory of linear prediction are presented. 32 pp.

- Ø● **RM-3092-PR (AD 274838). Augmentation analysis of the Einstein gravitational field.** D. G. B. Edelen. April 1962. Unclassified.

Groundwork for investigating the possibility of the control of gravitational fields in the neighborhood of a massive body. The Einstein equations for the gravitational field are examined under the assumption that one knows an exact solution of these equations for a given momentum-energy tensor. The problem of superimposing a weak gravitational field on a known field is studied, as well as the "engineering problem" of how momentum energy should be distributed in the neighborhood of a massive body so as to effect a given change in the gravitational field. 32 pp.

- Ø● **RM-3096-PR (AD 274599). Idealized sheath theory and satellite charge-up in the Van Allen region.** G. E. Modesitt. April 1962. Unclassified.

A continuation of the investigation of the effects of the space environment on artificial earth satellites. As a possible contribution in determining the electric potential of naturally charged satellites, the concept of the idealized sheath introduced by Langmuir and Mott-Smith is studied through the use of distribution functions. It is shown that the functions are discontinuous in velocity variables and lead to the same results as particle trajectory theory. The limitations of the sheath theory and its connection with space-charge-limited diode theory are discussed. It is also shown that under certain assumptions the potential on a satellite whose diameter is smaller than the local Debye length will reach 3500 volts negative in the more intense regions of the Van Allen electron belt. The equilibrium potential decreases with increasing size of the satellite, with a limiting value of -35,000 volts for satellites much greater than the Debye length in diameter. 43 pp.

- **RM-3113-PR. Some numerical results using quasilinearization for nonlinear two-point boundary value problems.** R. E. Bellman, R. E. Kalaba, and B. Kotkin. April 1962. Unclassified.

A memorandum showing how two devices—one a quasilinearization technique and the other a memory-saving technique—lead to the successful solution of some nonlinear two-point boundary value problems. Various investigations in modern physics lead to such equations. The concepts should be of particular value to studies of missile and aircraft trajectory optimization, where such equations abound. 22 pp. Tables.

- **RM-3122-PR. On asymptotic behavior of solutions of second-order differential equations.** R. E. Bellman. April 1962. Unclassified.

A study concerned with the investigation of the asymptotic behavior of solutions of differential equations. In particular, this memorandum discusses the problem of matching given initial conditions with given asymptotic conditions for solutions of a particular class of second-order differential equations. 16 pp.

PAPERS

RAOP-1 (out of print). Analysis and performance of the ramjet engine. G. Grimmer and R. W. Krueger. 10-1-47. Unclassified.

An analysis of the flow through the ramjet engine and expressions from which the performance (thrust and specific fuel consumption) can be calculated. 70 pp. Illus.

RAOP-2. A simplified method for computing the equilibrium composition of gaseous systems. F. J. Krieger and W. B. White. 1-9-48. Unclassified.

A procedure for computing the equilibrium composition of a gaseous system of any degree of complexity. The necessary relations are tabulated either manually or by punched cards. Each of the major components is given as a linear expression of the minor components only. 9 pp. Published in the *Journal of Chemical Physics*, April, 1948.

RAOP-3. The G-layer of the ionosphere. D. K. Bailey and D. H. Menzel. 8-16-47. Unclassified.

A survey of observational data on a possible fourth or "G" layer, situated above the other three layers of the ionosphere. 4 pp. Illus. Published in the *Relations entre les Phénomènes Solaires et Géophysiques*, ed. by La Revue d'Optique, Colloque International Tenu à Lyon, France, 1947. 1.800 fr. Presented before the Colloque International in Lyon, France, Summer, 1947.

RAOP-4. On a new method for exploring the upper ionosphere. D. K. Bailey. 10-3-47. Unclassified.

A study of refraction experienced by radio waves which arrive at the earth after passage through the entire ionosphere, as a method of exploring the upper atmosphere. A discussion of (1) an expression for the refraction of radio waves which pass through a parabolic layer model and (2) an experimental technique for measuring refraction. 10 pp. Illus. Published in *Terrestrial Magnetism and Atmospheric Electricity*, March, 1948.

RAOP-7. On the power function of a sign test formed by using subsamples. J. E. Walsh. 1-7-48. Unclassified.

A note on the power efficiency of the significance tests for the median. The case considered is one in which each observation is drawn from the same normal population. 13 pp. Presented before the Institute of Mathematical Statistics in New York City, April, 1948.

RAOP-8. On the "information" lost by using a *t*-test when the population variance is known. J. E. Walsh. 7-27-48. Unclassified.

A discussion of the use of the power function as a means of determining how much "information" is lost by using some other test in place of the most powerful test of a given hypothesis. The case of using a *t*-test for the mean of a normal population with known variance is analyzed. 6 pp. Published in the *Journal of the American Statistical Association*, March, 1949.

RAOP-10. Concerning compound randomization in the binary system. J. E. Walsh. 6-21-49. Unclassified.

An approach to the problem of constructing a set of random digits which can be proved sufficiently random for most applications if certain intuitively acceptable conditions are satisfied. 11 pp. Published in *The Annals of Mathematical Statistics*, December, 1949.

RAOP-13. Some bounded significance level properties of the equal-tail sign test. J. E. Walsh. 1-3-51. Unclassified.

An analysis of the significance level of the equal-tail sign test for a population median under both normal and generalized conditions. 8 pp. Published in *The Annals of Mathematical Statistics*, September, 1951. Presented before the Institute of Mathematical Statistics at Madison, Wisconsin, September, 1948.

RAOP-14. Branching processes. T. E. Harris. 7-29-48. Unclassified.

An examination of several theories of the stochastic process (known as the Bernoulli Process). This is an idealized model for a type of phenomenon encountered in genetics, nuclear physics.

and other studies. 36 pp. See P-152. Published in *The Annals of Mathematical Statistics*, December, 1948, and in the *Annals of Mathematics*, March, 1952. Presented before the Institute of Mathematical Statistics at Berkeley, California, December, 1947.

RAOP-17. Sampling inspection plans for continuous production. M. A. Girshick. 5-10-48. Unclassified.

A discussion of a sampling inspection plan as a useful control of the outgoing quality of products on a scientific basis. This method (1) classifies the product units as either defective or nondefective and (2) establishes a prescribed upper limit to the average outgoing quality of the final product entering into consumption channels. 20 pp. Presented before the Institute of Mathematical Statistics at Berkeley, California, June, 1948.

Ø **RAOP-18. Probability that a meteorite will hit or penetrate a body situated in the vicinity of the earth.** George Grimminger. 4-22-48. Unclassified.

An attempt to estimate the probability that a body situated in the vicinity of the earth will be hit by a meteorite. The metal plate thickness necessary to prevent perforation by the impact of different sized meteorites is also evaluated. 8 pp. Illus. Published in the *Journal of Applied Physics*, October, 1948.

RAOP-19 (out of print). Calculation of the composition of multicomponent propellant gases. Battelle Memorial Institute. 1-10-49. Unclassified.

A study to determine the composition of multicomponent gas mixtures. The method presented reduces the labor connected with computing theoretical rocket propellant performance of systems which contain more than six or seven atomic and molecular species in the gas phase. 12 pp. Illus. Published in the *Third Symposium on Combustion and Flame Explosion Phenomena*, 1949. Presented before the Third Symposium on Combustion at The University of Wisconsin at Madison, Wisconsin, September, 1948.

● **RAOP-23. The design of constant-volume missile fuselages having minimum drag at supersonic speeds.** A. H. Green. 6-11-48. Unclassified.

A discussion of the factors influencing the design of missile fuselages. This study analyzes (1) the optimum proportions which result in minimum drag and (2) the tactical and design requirements of a missile fuselage with specific geometrical configuration and supersonic speed. 30 pp. Illus.

RAOP-26 (out of print). The application of the Schlieren method to the quantitative measurement of mixing gases in jets. Battelle Memorial Institute. 6-23-48. Unclassified.

An analysis of the Schlieren technique applied quantitatively. The medium through which the time mean concentration of helium is measured at various points in a freely expanding jet is described. 14 pp. Illus. Published in the *Third Symposium on Combustion and Flame Explosion Phenomena*, 1949. Presented before the Third Symposium on Combustion at The University of Wisconsin at Madison, Wisconsin, September, 1948.

RAOP-27 (out of print). Estimated thermodynamic functions of free radicals in combustion gases. Battelle Memorial Institute. 10-14-48. Unclassified.

A presentation of working tables of the necessary thermodynamic functions for several free radicals. These are: AlO , AlH , BH , CH , NH , ClF , CS , and BF and may be formed in the combustion of rocket propellant mixtures. 27 pp. Published in the *Third Symposium on Combustion and Flame Explosion Phenomena*, 1949. Presented in a symposium at The University of Wisconsin at Madison, Wisconsin, September, 1948.

RAOP-28 (out of print). The automatic sampling of gases at high temperatures and pressures. Battelle Memorial Institute. 6-21-48. Unclassified.

A description of a sampling device by which the combustion progress in high-intensity combustors is investigated. Special problems with high rates of heat transfer, temperature, and pressure are also solved. 18 pp. Illus. Published in the *Third Symposium on Combustion and Flame Explosion Phenomena*, 1949. Presented in a symposium at The University of Wisconsin at Madison, Wisconsin, September, 1948.

- **RAOP-31. A note on the numerical problem of matrix inversion.** W. B. White. 7-19-48. Unclassified.

A presentation of a method for computing the inverse of a matrix. The author extends the method of Crout for solving a system of linear equations which involves three basic operations. 3 pp.

- RAOP-32 (out of print). On the best choice of sample sizes for a *t*-test when the ratio of variances is known.** J. E. Walsh. 1-5-49. Unclassified.

An analysis of a situation in which the difference of the means of two normal populations is tested. This is determined on the basis of a sample from each population in which the ratio of the population variances is known. 6 pp. Published in the *Journal of the American Statistical Association*, December, 1949.

- RAOP-33. Principles of structural design for minimum weight.** F. R. Shanley. 8-4-48. Unclassified.

A study in which (1) the engineering significance of the structural index and its applications to design problems are discussed and (2) methods of comparing various materials on a weight basis are developed and applied to several aluminum alloys, magnesium alloy, and stainless steel. 9 pp. Illus. See also R-222 (out of print). Published in the *Journal of the Aeronautical Sciences*, March, 1949. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, July 15-16, 1948.

- RAOP-37. Bayes and minimax solutions of sequential decision problems.** K. J. Arrow, D. H. Blackwell, and M. A. Girshick. 8-30-48. Unclassified.

A discussion of sequential decision problem solutions. Analyzed in the report are (1) the construction of the Bayes solutions, (2) the optimum sequential procedure for a dichotomy with linear cost function, (3) a method which determines exact values of hypotheses probabilities, (4) multivalued decisions and the game theory, (5) some examples of trichotomies, (6) another optimum property of the sequential probability ratio test, and (7) the continuity of the risk function of the optimum test. 48 pp. Illus. Published in *Econometrica*, July-October, 1949. Presented before the Institute of Mathematical Statistics at Madison, Wisconsin, September 9, 1948.

- RAOP-38. On the theory of age-dependent stochastic branching processes.** R. E. Bellman and T. E. Harris. 7-14-50. Unclassified.

An investigation of a problem in which a particle existing at time $t_1 = 0$ is assumed to have a probability q_n , $n \geq 0$, of being transformed into n similar particles at some random time $t > 0$. The probability distribution of $Z(t)$, the number of particles in existence at time t , is required. 46 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, December, 1948. Presented before the Institute of Mathematical Statistics at Cleveland, Ohio, December, 1949.

- RAOP-40 (out of print). Effects of source and shadow shield geometry on the scattering of gamma rays.** M. S. Plesset, C. Hastings, Jr., and S. T. Cohen. 2-26-48. Unclassified.

A continuation and amplification of some specifically geometrical problems occurring in quantitative analysis of the intensity of gamma rays and neutrons scattered by air. 59 pp. Illus. Also published as RM-32.

- RAOP-41. The possibility of a universal social welfare function.** K. J. Arrow. 9-26-48. Unclassified.

An examination of the possibility and basis for a universal social welfare function. 19 pp. See also RM-67. Published as *Social Choice and Individual Values*, Cowles Commission Monograph No. 12, 1951. Presented before the Econometric Society at Cleveland, Ohio, December, 1948.

- RAOP-42. Some bounded significance level tests of whether the largest observations of a set are too small.** J. E. Walsh. 10-13-48. Unclassified.

An abstract of a report on some bounded significance level tests of whether the largest observations of a set are too small. 1 p. See also P-61. Published in *The Annals of Mathematical Statistics*, December, 1948.

RAOP-44. Some tests of the randomness of a million digits. B. B. Brown. 10-19-48.
Unclassified.

A report on the randomness of a million digits produced by a random digit generator. They are examined for randomness by (1) the Frequency test, (2) the Poker test, (3) the Serial test, and (4) the Run test. 15 pp. Illus. Also published as RM-38. See also P-113. Presented before the American Statistical Association at Cleveland, Ohio, December 29, 1948.

P-46 (out of print). Arc melting of refractory metals, such as titanium, and their alloys. Battelle Memorial Institute. 10-27-48. Unclassified.

A description of a simple type of laboratory arc-melting furnace for the experimental investigation of refractory metals and their alloys. The melting of titanium-base alloys is emphasized, and some properties of ingots arc-melted from Bureau of Mines titanium powder are cited. 22 pp. Illus. Published in *Steel*, May 2, 1949.

P-47. Isomorphism of games, and strategic equivalence. J. C. C. McKinsey. 11-22-48.
Unclassified.

A detailed proof of the assumption that a precise mathematical condition *A* that is necessary for strategic equivalence in the theory of games implies *B*, a precise mathematical condition recognized as sufficient for strategic equivalence. 41 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950. Presented before the American Mathematical Society at Columbus, Ohio, December 28-30, 1948.

P-49. The determination of many-commodity preference scales by two-commodity comparisons. K. J. Arrow and J. W. T. Youngs. 8-3-48. Unclassified.

A comparison of two commodities under the customary economic assumptions to determine a preference scale of many commodities. 16 pp. Published in *Metroeconomica*, December, 1952.

P-50. A solution of the laminar boundary layer equations for a compressible fluid with variable properties including dissociation. L. L. Moore. 11-1-51.
Unclassified.

An evaluation of the local skin friction and heat transfer coefficients for a flat plate in compressible flow. The information is ascertained over a wide range of Mach numbers (1-20), and the laminar boundary layer equations are solved for both the unheated plate and heated plate cases. 81 pp. Illus. Extended in P-214. Published in the *Journal of the Aeronautical Sciences*, August, 1952. Presented before the American Society of Mechanical Engineers at Los Angeles, California, February 9, 1949.

• **P-51. Effect of creep on column deflection.** T. P. Higgins, Jr. 6-26-51. Unclassified.

A theoretical approach to the design of columns which operate at elevated temperatures. A method is proposed by which the allowable column stress may be determined as a function of the material, operating temperature, slenderness ratio, and life of the column. 25 pp. Illus. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, July 16, 1952.

P-53 (out of print). Titanium-base alloys. Battelle Memorial Institute. 12-2-48.
Unclassified.

A summary of an investigation by the Battelle Memorial Institute on titanium-base alloys. 13 pp. Illus. Published as Office of Naval Research Paper No. 13, December, 1948. Presented in a symposium on titanium at Washington, D.C., December 16, 1948.

P-54 (out of print). A method for measuring surface heat transfer using cyclic temperature variation. Battelle Memorial Institute. 11-30-48. Unclassified.

A theoretical explanation of the quantity of heat transferred and the average temperature difference between a solid and fluid. 27 pp. Illus. Published in the *Proceedings of the Heat Transfer and Fluid Mechanics Institute*, June, 1949. Presented before the Heat Transfer and Fluid Mechanics Institute at Berkeley, California, June 22-24, 1949.

P-55 (out of print). **A study of freely expanding inhomogeneous jets.** Battelle Memorial Institute. 12-14-48. Unclassified.

An investigation of the effect of inhomogeneous density fields on values of the mean concentration in freely expanding jets. 20 pp. Illus. Published in the *Proceedings of the Heat Transfer and Fluid Mechanics Institute*, June, 1949. Presented before the Heat Transfer and Fluid Mechanics Institute at Berkeley, California, June 22-24, 1949.

P-57. Solutions of discrete, two-person games. L. S. Shapley, S. Karlin, and H. F. Bohnenblust. 1-14-49. Unclassified.

A study of the fundamental relationship between the dimensions of optimal strategy sets. Discussed in the paper are (1) the set of games with unique solutions, (2) the construction of a game matrix with a given solution, and (3) the solution of matrices with special diagonal properties. 29 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950.

P-58 (out of print). **Physiological damage due to microwaves.** Collins Radio Co. 1-12-49. Unclassified.

An investigation of possible injury to people who are working with microwave equipment. Such injury is found to occur at relatively low field intensity. 14 pp. Illus. Published in *Electronics*, December, 1948.

P-60. The simulation of combustion models in wind tunnels. B. W. Augenstein. 12-27-48. Unclassified.

A study of the extent to which duct flow with burning can be simulated without heat addition in a wind tunnel (i.e., a cold test). 6 pp. Published in the *Journal of the Aeronautical Sciences*, March, 1949.

P-61. Some nonparametric tests of whether the largest observations of a set are too large or too small. J. E. Walsh. 2-27-50. Unclassified.

A presentation of some nonparametric tests—of whether the r largest observations of the set are too large or too small to be consistent with the hypothesis that these populations have a common median value. The observations are statistically independent and are drawn from continuous symmetrical population. 8 pp. See also RAOP-42. Published in *The Annals of Mathematical Statistics*, December, 1950. Presented before the Institute of Mathematical Statistics at Madison, Wisconsin, September, 1948.

• **P-62** (out of print). **Heights of ionized regions.** W. W. Kellogg. 2-14-49. Unclassified.

A novel modification of the older theoretical explanations of ionization processes in the ionosphere. 15 pp. Illus. Presented before the American Meteorological Society at La Jolla, California, June 1949.

P-63 (out of print). **The effect of oxygen, nitrogen, and hydrogen on iodide-refined titanium.** Battelle Memorial Institute. 2-21-49. Unclassified.

An evaluation of certain gas effects on titanium of the highest purity available. These alloys of titanium contain 0.25, 0.5, and 1 atomic per cent of oxygen, nitrogen, and hydrogen, respectively, and are made from rods of iodide-refined titanium by a gaseous diffusion method. The rods are tested for their density, electrical resistivity, microstructure, mechanical properties, and cold-working characteristics. 25 pp. Illus. Published in the *Journal of Metals*, September, 1949. Presented at a meeting of the American Institute of Mining and Metallurgical Engineers at New York City, September, 1949.

• **P-65. Some estimates and tests based on r smallest values in a sample.** J. E. Walsh. 2-24-50. Unclassified.

An analysis of a situation in which only the r smallest values of a sample of size n are available. The case is considered in which n is large and r is of the form $pn + O(\sqrt{n})$. Properties of some well-known nonparametric point estimates, confidence intervals, and significance tests for the $100p$ per cent point of the population are examined. 4 pp. Illus. Published in *The Annals of Mathematical Statistics*, September, 1950. Presented before the Institute of Mathematical Statistics at New York City, December 27-30, 1949.

P-66. Games with continuous, convex payoff. H. F. Bohnenblust, S. Karlin, and L. S. Shapley. 8-12-49. Unclassified.

A study of a special class of games in which the strategies of one player form a compact and convex region B of finite-dimensional Euclidean space while those of the other form an arbitrary set A . 19 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950.

• **P-67 (out of print). Turbulence in the upper atmosphere.** W. W. Kellogg. 3-14-49. Unclassified.

An examination of clues which show turbulence existing in the upper atmosphere. Stratospheric temperatures and calculations of vertical velocities are also discussed. 12 pp. Illus. Presented to the Upper Atmosphere Symposium at the California Institute of Technology, Pasadena, California, May 1950.

P-68. Analysis of stress-strain-time relations from the engineering viewpoint. F. R. Shanley. September 1951. Unclassified.

A step-by-step development of stress-strain diagrams for various loading histories in which elastic action is assumed to be instantaneous and reversible; and plastic action, to occur at constant stress as a function of stress, time, and extent of plastic straining. 38 pp. Illus. See also R-222 (out of print) and RM-2011. Published in *Weight-Strength Analysis of Aircraft Structures*, McGraw-Hill Book Company, Inc., New York, 1952. Presented in a symposium on plasticity at Brown University, Providence, Rhode Island, April 4-6, 1949.

• **P-69 (out of print). Market mechanisms and maximization.** P. A. Samuelson. 3-28-49. Unclassified.

A study of the relationship between the computational methods of "linear programming" and the logic of market mechanisms. Discussed in the paper are (1) the theory of comparative advantage and (2) the cheapest-adequate-diet problem. 46 pp. Illus. See also a supplementary publication, RM-179 (out of print).

P-70. The conditional expectancy of mental disease. H. Goldhamer and A. W. Marshall. 9-11-50. Unclassified.

A presentation of a simple expectancy measure for mental disease of value for scientific analysis with a new expectancy table based on this measure. Expectancies are extended to cover noninstitutionalized psychotics. 21 pp. Published in R-157 (out of print) and in *Psychosis and Civilization*, The Free Press, Glencoe, Illinois, 1953. Presented before the American Sociological Society at New York City, December 28-30, 1949.

P-71 (out of print). The vapor-phase deposition of refractory materials: general conditions and apparatus. Battelle Memorial Institute. 3-28-49. Unclassified.

A description of applying coatings of refractory materials by vapor-phase deposition. Discussed in the report are (1) several properties of the deposits, (2) their limitations, and (3) their potential uses as protective coatings for high-temperature service. 24 pp. Illus. Published in the *Transactions of the Electrochemical Society*, Vol. 96, 1949. Presented before the Electrochemical Society at Philadelphia, Pennsylvania, October, 1949.

P-73. Iterates of fractional order. R. P. Isaacs. 11-3-49. Unclassified.

A tabulation of an iteration problem. E is any space whatever. $g(x)$ is a function mapping E into E . The time factor is calculated during which there exists a function $f(x)$, of the same type, such as $f[f(x)] = g(x)$. 12 pp. Published in the *Canadian Journal of Mathematics*, November, 1950.

P-74. Some applications of a theorem on convex functions. S. Karlin and L. S. Shapley. 4-18-49. Unclassified.

A presentation of several applications of a theorem on convex functions. From these results certain extensions of the theorem of Helly, approximation and fitting results, and theorems for the n -dimensional unit sphere are determined. 9 pp. Illus. Published in the *Annals of Mathematics*, April, 1950.

- **P-78. Some notes on computation of games solutions.** G. W. Brown. 4-25-49. Unclassified.

A presentation of several dynamical systems whose steady-state solutions yield solutions to a discrete game matrix. Considered in the report are (1) various systems of differential equations for a symmetric game, (2) related systems of difference equations for digital computation, and (3) the linear programming problem represented as a symmetric game. 6 pp. See also P-154. Presented before the Institute of Numerical Analysis, Los Angeles, California, June 16, 1949.

- P-78B. Notes on the solution of linear systems involving inequalities.** G. W. Brown. 10-3-49. Unclassified.

A discussion of an iterative solution for minimizing a linear function $\sum b_j x_j$. 6 pp. Published in the *Proceedings of a Second Symposium on Large-scale Digital Calculating Machinery*, 1949. Presented in a symposium on Large-scale Digital Calculating Machinery at Cambridge, Massachusetts, September, 1949.

- P-80. On the power function of the "best" t -test solution of the Behrens-Fisher problem.** J. E. Walsh. 6-20-49. Unclassified.

A comparison of the power function of the Scheffé test with the power function of the corresponding most powerful test for the case in which the ratio of variances is known. 4 pp. Published in *The Annals of Mathematical Statistics*, December, 1949.

- P-81 (out of print). An electromagnetic blood flow meter.** Collins Radio Co. 4-19-49. Unclassified.

A description of the development and construction of an instrument for electrically measuring the rate of flow of blood through a glass cannula inserted within a vessel of an anesthetized animal. 12 pp. Illus. Published in *The Review of Scientific Instruments*, February, 1949.

- P-82. Simplified analysis of general instability of stiffened shells in pure bending.** F. R. Shanley. 5-12-49. Unclassified.

An analysis of a coefficient which (1) determines the size of frames for any given diameter, bending moment, and frame spacing and (2) prevents general instability in the optimum design of stiffened shells. 10 pp. Illus. See also R-222 (out of print). Published in the *Journal of the Aeronautical Sciences*, October, 1949.

- P-84. Some two-person games involving bluffing.** R. E. Bellman and D. H. Blackwell. 5-18-49. Unclassified.

A study of a class of games which may be handled by uniform techniques. 10 pp. See also P-168. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 35, 1949.

- P-85. On a theorem of Ville.** H. F. Bohnenblust and S. Karlin. 5-27-49. Unclassified.

An extension of the theorems of Ville and Kakutani under certain conditions to infinite-dimensional spaces. The results are utilized in the theory of nondiscrete games. 8 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950.

- P-86. Large sample tests and confidence intervals for mortality rates.** J. E. Walsh. 10-24-49. Unclassified.

A presentation of methods which determine some valid large sample tests and confidence intervals for the mortality rate. Differences are examined between customary "unit" deaths estimated by policy coverage and actual mortality governed solely by deaths of individuals. 11 pp. Published in the *Journal of the American Statistical Association*, June, 1950.

- P-87. Lift on inclined bodies of revolution in hypersonic flow.** G. Grimminger, E. P. Williams, and G. B. W. Young. 4-17-50. Unclassified.

An analysis by approximate methods of the body lift in hypersonic flow. From correlating existing experimental data, the probable body lift variation is indicated over a wide range of Mach numbers extending from low supersonic to hypersonic. 51 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, November, 1950. Presented before the Institute of the Aeronautical Sciences in New York City, January 23-26, 1950.

P-88. Stochastic (Monte Carlo) attenuation analysis. Herman Kahn. 7-14-49. Unclassified.

An application of random sampling techniques to the problem of neutron and gamma-ray attenuation in thick shields. Deductions are made about a large number of neutrons from the study of comparatively few. 21 pp. Illus. See also P-132. Published in *Nucleonics*, May and June, 1950, issues. Presented in a symposium on the Monte Carlo method at the University of California at Los Angeles, June 30, 1949.

P-89. Minimum weight of stiffened cylindrical shells in pure bending. W. R. Micks. 6-1-49. Unclassified.

An extension to include the weight of the circumferential frames of methods previously developed for determining minimum weight of stiffened cylindrical shells in bending, with curves showing the variation of frame weight, panel weight, and total weight with variations in structural index and frame spacing. 16 pp. Illus. See also R-222 (out of print). Published in the *Journal of the Aeronautical Sciences*, April, 1950.

P-90. Tables of Hermite polynomials and the derivations of the error function. J. I. Marcum. 12-29-48. Unclassified.

A presentation of computations for the Gram-Charlier series approximations to certain distribution functions for a sine wave plus random noise. 241 pp. Published in *Mathematical Tables and Other Aids to Computation*, October 28, 1949.

• **P-91. On the power function of tests of percentage points based on the noncentral t -statistics.** J. E. Walsh. 11-8-49. Unclassified.

A study of the power function of one-sided tests of the 100β per cent point of a normal population which are based on the noncentral t -statistic. An approximate expression, with desirable properties from the viewpoint of power function comparisons, is determined for the power function. 3 pp.

P-92. Some comments on the efficiency of significance tests. J. E. Walsh. 7-29-49. Unclassified.

A discussion of an estimate method which determines the efficiency of a significance test. This process associates a statistic with the test and defines the efficiency of the test to be the efficiency of the statistic considered as an estimate. Its power function implications are examined for several cases in which uniformly most powerful tests exist. 10 pp. Published in *Human Biology*, May, 1950.

P-93. The prediction of social and technological events. A. Kaplan, A. L. Skogstad, and M. A. Girshick. 4-1-49. Unclassified.

A report on a pilot study of the prediction of social and technological events. From questioning twenty-six predictors, certain criteria were estimated: (1) the success of such prediction, (2) its possible improvement, and (3) the prior appraisal of the success to be expected. 31 pp. Published in the *Public Opinion Quarterly*, Spring, 1950.

• **P-94. Integral of the Gaussian distribution over an offset ellipse.** H. H. Germond. 7-28-49. Unclassified.

A numerical method which determines the integral of the bivariate Gaussian distribution over an offset ellipse. Skeleton tables give four decimal place values of the integral for certain offset ellipses. 13 pp. Illus. Presented before the Institute of Mathematical Statistics at Boulder, Colorado, August 29–September 2, 1949.

P-96. The future of mathematical statistics and quality control. G. W. Brown. 8-18-49. Unclassified.

A paper which discusses a few specific areas of activity in mathematical statistics in the field of quality control. 7 pp. Published in the *Bulletin of the International Statistical Institute*, Part 2, Vol. XXXII, 1950. Presented before the International Statistics Institute at Berne, Switzerland, September 5, 1949.

P-97. Geometry of reduced moment spaces. S. Karlin and L. S. Shapley. 8-11-49. Unclassified.

Proofs of several theorems on the geometry of reduced moment spaces. 7 pp. Superseded by P-227. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 35, 1949, and in the *Annals of Mathematics Studies*, No. 24, 1950.

P-99 (out of print). A comparative study of the temperature gradients produced by various thermogenic agents. Collins Radio Co. 8-12-49. Unclassified.

A study of the factors which determine the temperature changes occurring in living and dead tissues as a result of irradiation. The tissues are exposed to 1600 cm, 75 cm, $12\frac{1}{4}$ cm, $8\frac{1}{2}$ cm, and 3 cm electromagnetic wave lengths and infrared, and the temperatures are recorded at four different depths of tissue. 15 pp. Illus. Published in the *Archives of Physical Medicine*, March, 1949.

P-100. Polynomial games. M. Dresher, S. Karlin, and L. S. Shapley. 4-13-50. Unclassified.

A presentation of a basis for a theory of two-person zero-sum games in which the payoff is a polynomial function of the two strategy variables. 28 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950. Presented before the International Congress of Mathematicians at Cambridge, Massachusetts, December, 1950.

● **P-101. Transtability flutter of supersonic aircraft panels.** R. P. Isaacs. 7-1-49. Unclassified.

An analysis of the transtability flutter of supersonic aircraft panels. A model of a beam clamped at both ends is used, which is slightly buckled by forcing the ends toward each other. A supersonic airstream flows parallel to the beam. 11 pp. Illus. Published in the *Bulletin of the American Mathematical Society*, January, 1950. Presented before the American Mathematical Society at Pasadena, California, November 26, 1949.

P-102. On a generalization of the Behrens-Fisher problem. J. E. Walsh. 11-16-49. Unclassified.

A generalization of the Behrens-Fisher problem which may be approximated by many practical situations. A solution is presented for the generalized situation, and some efficiency properties of this solution are investigated. 11 pp. Published in *Human Biology*, May, 1950. Presented before the Institute of Mathematical Statistics at Chapel Hill, North Carolina, March, 1950.

P-103. Method of solution in game theory. Melvin Dresher. 7-29-49. Unclassified.

A discussion of methods of solving two-person zero-sum games. 2 pp. Published in *Econometrica*, April, 1950. Presented before the American Mathematical Society at Boulder, Colorado, September 4, 1949.

P-105. Planning defense production. C. J. Hitch. 9-29-49. Unclassified.

A talk on the production problems of an advanced defense economy. The method considered is one in which the defense resources or budget is allocated among the production of the various goods and services contributing to the nation's security. 12 pp. Published in the *Proceedings of the American Economic Association*, May, 1950. Presented before the American Economic Association in New York City, December 27, 1949.

P-106. Total reconnaissance with total countermeasures: simplified model. Seymour Sherman. 8-5-49. Unclassified.

Proof of a theorem and two corollaries on a simplified model of total reconnaissance with total countermeasures. 2 pp. Also published as RM-202. Published in the *Proceedings of the American Mathematical Society*, April, 1951. Presented before the American Mathematical Society at Washington, D.C., April 29, 1950.

P-108. An airframe production function. A. A. Alchian. 10-20-49. Unclassified.

A study of the reliability of learning curves and the Minus One-third Curve or the Eighty Per Cent Curve. The determining factors of the curve, the universality throughout the industry, and profitable fields of research are also discussed. 15 pp. Illus. Abstracted in *Econometrica*, June, 1950. Presented before the American Economic Association at New York City, December 27-30, 1949.

P-109. Productivity and welfare in Soviet agriculture. J. A. Kershaw. 11-4-49. Unclassified.

An examination of the Jasny theses on Soviet agriculture that (1) labor productivity increased only slightly between 1928 and 1938 and (2) the welfare of farmer and urbanite was not higher in the later period. These, while essentially true, are found to have possible misleading implications for prediction of future industrial output. 13 pp. Published in *The American Economic Review*, March, 1950.

P-112. Concerning the effect of small correlation on certain large sample tests and confidence intervals for the mean. J. E. Walsh. 11-17-49. Unclassified.

A study of statistical tests and confidence intervals for the population mean. The case considered is one in which the random sample requirement is violated and the number of observations is large. 7 pp. Published in the *Journal of the American Statistical Association*, March, 1951.

P-113. History of RAND's random digits: summary. G. W. Brown. June 1949. Unclassified.

A brief outline of the history of RAND's random digits. Described are (1) the random digit generator, (2) various tests applied to the digits, and (3) the method of alteration of the digits to remove a bias. 5 pp. See also RAOP-44. Published in the *Applied Mathematics Series-12*, June 11, 1951. Presented before the Monte Carlo Conference at the University of California at Los Angeles, June, 1949.

P-114. Rational approximation in high-speed computing. C. Hastings, Jr. 12-2-49. Unclassified.

A report on the use of rational approximation in high-speed computing. The work is designed around the IBM-type 604 calculating punch with occasional reference to the future IBM card-programmed electronic calculator. 13 pp. Published in the *Proceedings of the Computation Seminar*, December, 1949. Presented before the Computation Forum at Endicott, New York, December 5-9, 1949.

P-116. Efficient allocation of resources. T. C. Koopmans. 12-7-49. Unclassified.

A study of the efficient allocation problem in production by the evaluation of the merits of private or corporate enterprise versus a centrally directed economy. 14 pp. Illus. Published in *Econometrica*, October, 1951. Presented before a joint meeting of the American Statistical Association, the American Economic Association, and the Econometric Society in New York City, December 29, 1949.

P-117. International commodity equilibrium: solution by electric analogue. Stephen Enke. 12-12-49. Unclassified.

An evaluation of an electric analogue as a prediction factor in equilibrium solutions for regional cases. These economic consequences may be caused by schedule changes in the supply or demand in any region or by a variation in freight cost between two regions. 10 pp. Illus. Published in *Econometrica*, January, 1951.

P-119. The American soldier and the sociology of military organization. Hans Speier. 5-9-50. Unclassified.

A critical review of *The American Soldier*. Several problems discussed are (1) the place occupied by these volumes in the sociological history of war, (2) the lessons to be learned on the moral fabric of American society, (3) the relationship between policy making and attitude research, and (4) the degree of opinion *projection* conforming to rank or social status. 37 pp. Published in *Continuities in Social Research*, ed. by P. F. Lazarsfeld and R. K. Merton, The Free Press, Glencoe, Illinois, 1950. Reprinted in H. Speier, *Social Order and the Risks of War*, George W. Stewart, Publisher, Inc., New York, 1952. Presented before the American Sociological Society, New York, September, 1950.

• **P-120. The thermodynamic properties of boric oxide and of aluminum oxide in the ideal gaseous state.** H. K. Kallmann and F. J. Krieger. 2-1-49. Unclassified.

A study to determine the thermodynamic properties of heat capacity, enthalpy, entropy, and free energy by the methods of statistical thermodynamics. The fundamental vibration frequencies are computed by the theory of small vibrations from nonspectroscopically determined values of the internuclear distances and the bond stretching force constants. 22 pp.

P-121. Theory of blind navigation by dynamical measurements. S. H. Browne, I. K. Williams, and J. J. Gilvarry. 12-29-49. Unclassified.

A study of the differential equation in the blind navigation theory. The position of the vehicle is determined from dynamical measurements of the nongravitational acceleration b made internally. Three linear approximations to the gravitational field $g(r)$ of the earth and an intervalwise solution of trajectories of extended range are discussed for the equation solution. 30 pp. Illus. Based on R-144. Published in the *Journal of Applied Physics*, August, 1950.

P-122 (out of print). Effects of intense microwave radiation on living organisms. Collins Radio Co. 3-7-50. Unclassified.

A re-examination of intense microwave radiation effects on laboratory animals (1) to ascertain the physiological damage from such exposure and (2) to establish protective standards for personnel exposed to the radiations. 16 pp. Illus. Published in *Electronics*, May, 1949. Presented before the Institute of Radio Engineers in New York City, February, 1950.

P-123 (out of print). End-cooling of power tube filaments. Collins Radio Co. 12-1-49. Unclassified.

A study of a method which designs the end portion of a filament. The differential equation is studied which defines the temperature distribution in that portion of the vacuum tube filament that is cooled by conduction, and radiation is solved by numerical integration. 16 pp. Illus. Published in the *Journal of Applied Physics*, November, 1950.

P-124. Effect of torsional stiffness requirements on wing structural weight. W. R. Micks. 5-24-50. Unclassified.

A report to evaluate the increase in weight of an optimum-designed sheet-stiffener compression panel when the skin thickness is increased by an arbitrary amount. This method indicates the minimum amount by which the total weight of sheet and stiffeners may be increased to achieve a given increase in sheet thickness. 12 pp. Illus. See also R-222 (out of print). Published in the *Journal of the Aeronautical Sciences*, November, 1950.

P-125. First- and second-order theory of supersonic flow past bodies of revolution. M. D. Van Dyke. December 1949. Unclassified.

An investigation to improve the existing perturbation theories of axial and inclined supersonic flow past bodies of revolution. Studied in the report are (1) second-order solutions without recourse to the slender-body approximation, (2) the most advantageous use of first-order theory for inclined flow, and (3) one of the principal effects of viscosity. 2 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, March, 1951. Presented before the Institute of Aeronautical Sciences at New York City, January, 1950.

P-126. Russian labor productivity statistics. Walter Galenson. 1-17-50. Unclassified.

An analysis of Russian productivity statistics up to 1949. Examined in the report are (1) the concepts employed by Russian statisticians in computing labor productivity, (2) the trend of labor productivity in Russian industry since the inception of the five-year plans, and (3) the productivity changes in the coal mining industry to enumerate problems of evaluation productivity statistics. 30 pp. Published in the *Industrial and Labor Relations Review*, July, 1951.

P-128 (out of print). Kinetic study of the thermal decomposition of hydrazine vapor in a silica vessel. Battelle Memorial Institute. 1949. Unclassified.

A study of the effect of temperature and silica surface on the decomposition reaction of hydrazine to determine its thermal stability. 57 pp. Illus. Published in *Industrial and Engineering Chemistry*, Vol. 43, 1951. Presented before the Columbus Symposium of the American Chemical Society at Battelle Memorial Institute, Columbus, Ohio, March 24, 1950.

P-129. A large sample t -statistic which is insensitive to nonrandomness. J. E. Walsh. 8-8-50. Unclassified.

A study of statistical tests and confidence intervals for the population mean. The case considered is one in which (1) the random sample requirement is violated and (2) the number of observations is large. 7 pp. Illus. Published in the *Journal of the American Statistical Association*, March, 1951.

- **P-130. A class of integral equations.** Richard Latter. 3-1-50. Unclassified.
 A solution of three types of integral equations by Wienerhopf techniques. 8 pp. Illus. Presented before the American Society of Physicists at Washington, D.C., April 27-29, 1950.
- P-131. On games of timing.** Max Shiffman. 9-6-49. Unclassified.
 An analysis of a symmetric game of timing. The report shows (1) that there is a unique strategy which is either a density from some point a to 1, or there is a jump at 0 and a density from a to 1 and (2) that determining the density function depends on the solution of a certain integral equation with positive kernel. 39 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950. Presented before the American Mathematical Society at Berkeley, California, April 28-29, 1950.
- P-132. Modification of the Monte Carlo method.** Herman Kahn. 11-14-49. Unclassified.
 A study which evaluates integrals and the solutions to integral equations by random sampling. The techniques available to the computer that can reduce the size of the sample required are emphasized. 18 pp. See also P-88. Published in the *Proceedings of the Endicott Conference*, November 14, 1949.
- **P-133. Some tests for comparing percentage points of two arbitrary continuous populations.** A. W. Marshall and J. E. Walsh. 8-2-50. Unclassified.
 A comparison of samples from two continuous populations. The first has unique 100α per cent point θ_α , the second, unique 100β per cent point φ_β . Some easily applied significance tests for $\theta_\alpha - \varphi_\beta$ which are approximately valid for moderate- and large-size samples are presented. 10 pp. Presented before the International Congress of Mathematicians at Cambridge, Massachusetts, September, 1950.
- P-135. On the accuracy of the long-range ballistic rocket.** W. E. Frye. 6-14-56. Unclassified.
 An investigation of the accuracy of a V-2 type ballistic missile which is guided to the termination of propulsion and is in free flight thereafter. Considered in the report are (1) the effect of the earth's rotation and the re-entry into the atmosphere on the accuracy and (2) the errors from lack of thrust control. 33 pp. Illus. Published in the *Journal of Applied Physics*, May, 1951. Presented before the American Physical Society in Mexico City, June 21-24, 1950.
- P-136. Institutional vulnerability in mass society.** Philip Selznick. 4-5-50. Unclassified.
 A reformulation of the idea of *massness*. Through analysis of institutional vulnerability, a close inspection of our institutions is suggested to determine relevant sources of weakness and strength. 20 pp. Published in the *American Journal of Sociology*, January, 1951. Presented before the American Sociological Society at Denver, Colorado, September, 1950.
- **P-138 (out of print). A note on Cullwick's tentative explanation of the observed masses of mesons.** J. J. Gilvarry. 4-5-50. Unclassified.
 A critical review of Cullwick's proposal that a theory by Dewar and a hypothesis of Ritz are bases for explaining the observed masses of mesons. 3 pp.
- **P-139. On a theorem of Doob.** T. E. Harris. 4-17-50. Unclassified.
 A justification for the interchange of limiting process required in the heuristic approach of Doob to the Kolmogorov limiting distribution of the maximum deviation between a theoretical and an empirical distribution function. 9 pp.
- P-140. A simplification of games in extensive form.** W. D. Krentel, J. C. C. McKinsey, and W. V. Quine. 2-12-51. Unclassified.
 A study of game theory in *extensive* form applicable to military situations. The problem of a necessary and sufficient condition for the equivalence of two patterns of information is also discussed. 32 pp. Published in the *Duke Mathematical Journal*, December, 1951. Presented before the International Congress of Mathematicians at Cambridge, Massachusetts, August 30-September 6, 1950.
- P-141. Recurrence times for the Ehrenfest model.** R. E. Bellman and T. E. Harris. 11-8-50. Unclassified.
 A report on an Ehrenfest model with a continuous time parameter. 18 pp. Published in the *Pacific Journal of Mathematics*, June, 1951. Presented before the Institute of Mathematical Statistics at New York City, December, 1950.

P-142. Solutions of games by differential equations. G. W. Brown and J. von Neumann. 4-19-50. Unclassified.

A presentation of a new proof for the existence of a value and of good strategies for a zero-sum two-person game. 11 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950.

- **P-147. Gamma-ray transmission.** Richard Latter. 4-27-50. Unclassified.

A study of the various approximations in transmitting gamma rays through material media. 11 pp. Presented before the Physical Society at Mexico City, June, 1950.

P-150. Totalitarian communications as a means of control. Paul Kecskemeti. 5-4-50. Unclassified.

A study of the purposes and effects of a monopolistically controlled field of domestic mass communication such as occurs in totalitarian states. 12 pp. Published in the *Public Opinion Quarterly*, Summer, 1950.

P-152. Some mathematical models for branching processes. T. E. Harris. 6-14-50. Unclassified.

A consideration of a number of stochastic processes which have been used as models for branching phenomena. This paper is particularly concerned with limiting theorems and limiting distributions giving the behavior of systems studied after long periods of time. Various results especially applicable to the classical model of Galton and Watson and its multidimensional generalization are considered. Some Russian work not yet available in English is described. 53 pp. See also RAOP-14. Published in the *Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability*, 1951. Presented at the Second Symposium on Mathematical Statistics and Probability at Berkeley, California, August 9, 1950.

P-154. An iteration method of solving a game. J. B. Robinson. 6-1-50. Unclassified.

A demonstration of the validity of an iterative procedure suggested by G. W. Brown in P-78, "Some Notes on Computations of Games Solutions," in which each player in a two-person game chooses in turn the best pure strategy against the accumulated mixed strategy of his opponent up to that moment. 9 pp. Published in the *Annals of Mathematics*, September, 1951.

P-156. Some bounded significance level tests for the median. J. E. Walsh. 6-16-50. Unclassified.

A presentation of some tests of a population median whose significance levels are only approximate but cover a wide range of suitable values. The significance levels of these tests are exactly determined if the populations are symmetrical; they are bounded otherwise. 10 pp. Published in *The Annals of Mathematical Statistics*, March, 1949.

- **P-157. Scattering and absorption of gamma rays.** M. S. Plesset and S. T. Cohen. 6-1-50. Unclassified.

A formulation of the scattering and absorption in different materials of gamma rays through air and lead. 35 pp. Illus.

- **P-158. Expectations, positive transformations, and Tauberian theorems.** R. E. Bellman and T. E. Harris. 6-20-50. Unclassified.

An application of results on "positive" transformations to the solution of systems of linear integral equations of the convolution type and certain other integral equations. 27 pp.

P-159. On the general moment problem. R. E. Bellman and D. H. Blackwell. 7-7-50. Unclassified.

A method which theoretically resolves the general moment problem and provides the solution to the problem of characterizing the moment space of characteristic functions. 14 pp. Illus. Published in the *Annals of Mathematics*, September, 1951.

- **P-163. Capacitance of circular condenser.** Edgar Reich. 7-14-50. Unclassified.

A critical examination of an approximate formula for the capacitance of a circular parallel plate condenser with infinitely thin plates. The behavior of the leakage effect is studied. 4 pp.

P-167. On the definition of information. Edgar Reich. 7-25-50. Unclassified.

An investigation of a definition of information postulated on an invariance under certain types of transformations. Relation to the formulation of Shannon in "A Mathematical Theory of Communication" is shown. 9 pp. Published in the *Journal of Mathematics and Physics*, October, 1951, and in the *Proceedings of the Institute of Radio Engineers*, March, 1951. Presented before the American Mathematical Society at Los Angeles, California, November, 1950.

- **P-168. On games involving bluffing.** R. E. Bellman and D. H. Blackwell. 8-1-50. Unclassified.

An investigation of some sets of heuristic axioms of play for simple card games in order to determine the general pattern which contributes to the solution of the mathematical problem of the solution of maximizing or minimizing the expectation of a player in a many-moved two-person game. 32 pp. See also P-84. Published in *Rendiconti del Circolo Matematico di Palermo*, Series 2, Vol. 1, 1952.

P-169. Some statistical problems connected with stochastic processes. T. W. Anderson and D. A. Darling. 8-14-50. Unclassified.

A treatment of the statistical problem of testing the hypothesis that a sample of n independent, identically distributed, random variables have the common continuous distribution function $F(x)$ fixed in advance. 20 pp. Published in *The Annals of Mathematical Statistics*, June, 1952. Presented before the Institute of Mathematical Statistics at Chicago, Illinois, December 29, 1950.

P-171. Politburo images of Stalin. N. C. Leites, R. L. Garthoff, and E. Bernaut. 7-31-50. Unclassified.

A study of statements about Stalin made by Politburo members on the occasion of his seventieth birthday in December, 1949, and on the occasion of the elections to the Supreme Soviet in March, 1950. The two outstanding images are discussed: the popular image as the "People's Leader," and the more eclectic one of the "Party Chief." 49 pp. Published in *World Politics*, April, 1951.

P-172. Two-person cooperative games. J. F. Nash. 8-9-50. Unclassified.

A definition of the concepts of a general two-person cooperative game with the development of a concept of a solution. 12 pp. Published in *Econometrica*, January, 1953.

P-173. On the integral equation $\lambda f(x) = \int_0^a e^{-(x-y)^2} f(y) dy$. R. E. Bellman and R. Latter. 8-28-50. Unclassified.

A discussion of the characteristic value, λ_M , as $a \rightarrow \infty$, under certain assumptions concerning $K(x)$. A method is presented for obtaining λ_M when a is not large. 10 pp. Published in the *Proceedings of the American Mathematical Society*, December, 1952.

P-174. On an equation occurring in the harmonic analysis of viscous fluid flow. R. E. Bellman. 9-12-50. Unclassified.

A discussion about an equation occurring in the harmonic analysis of viscous fluid flow. 9 pp. Published in the *Quarterly Journal of Applied Mathematics*, July, 1951.

P-175. On approximate expressions for the exponential integral and the error function. R. E. Bellman. 9-19-50. Unclassified.

An indication of a method of evaluating a Laplace transform and its application to the exponential integral and the error function. 10 pp. Published in the *Journal of Mathematics and Physics*, January, 1952.

P-177. The choice among investment alternatives in Soviet economic theory. N. M. Kaplan. 10-31-51. Unclassified.

An examination of the proposals made by eleven Soviet economists on the question of investment choice. The paper stresses the possibility of wide disagreement over the future course of Soviet economic policy in view of the lack of unanimity, the absence of official resolution, and the nature of the proposals on the subject of investment choice. 22 pp. See revised version RM-539. Published in *The Journal of Political Economy*, April, 1952. Presented before the Econometric Society at Chicago, Illinois, December 27, 1950.

P-178 (out of print). Heat recovery and maximum thermodynamic efficiency in a rocket. Battelle Memorial Institute. 7-1-50. Unclassified.

A calculation of the maximum thermodynamic efficiency that can be obtained in a rocket. Consideration is given to a rocket designed to utilize the combustion-exhaust gases for preheating the fuel and oxidizer in an idealized countercurrent heat exchanger. 12 pp. Illus. Available as reprint (Code No. 19-50), American Rocket Society, New York City, 1951. 50¢. Presented before a joint meeting of the American Rocket Society and the American Society of Mechanical Engineers at New York City, December 1, 1950.

P-179. A large sample test of the hypothesis that one of two random variables is stochastically larger than the other. A. W. Marshall. 5-21-51. Unclassified.

A presentation of a large sample nonparametric test using grouped data. A statistic is proposed for testing the hypothesis that one of two random variables is stochastically larger than the other. 13 pp. Published in the *Journal of the American Statistical Association*, September, 1951.

P-180. Some nonparametric results for experimental designs. J. E. Walsh. 10-16-50. Unclassified.

Some nonparametric results which are usually valid for a well-known type of experimental design. 12 pp. Published in the *Journal of the American Statistical Association*, September, 1952. Presented before the Institute of Mathematical Statistics at Minneapolis, Minnesota, September, 1951.

P-181. Lunar parallax method of astronavigation. J. S. Thompson. 12-12-50. Unclassified.

A description of the elements of an astronavigation system, with an examination of criteria of accuracy that must be achieved by the system. 13 pp. Illus. Published in the *Journal of the Institute of Navigation*, February, 1952. Presented at the University of California at Berkeley, January, 1951.

P-182. The economic war potential of the USSR. J. A. Kershaw. 12-6-50. Unclassified.

A presentation of the problems of methodology and concept of economic war potential of the Soviet Union. It considers some of the definitional and conceptual problems in general and three rough measures of the Soviet potential compared with that of the United States. Factors which must modify any quantitative results, and which at the present time make precise measurement impossible, are discussed. 12 pp. Published in the *Papers and Proceedings of the American Economic Review*, May, 1951. Presented before the American Economic Association at Chicago, Illinois, December, 1950.

P-183. An analysis of some failure data. D. J. Davis. 2-12-52. Unclassified.

A summary of the rationale and statistical techniques employed in the analysis of some failure data obtained from operations performed by machines and people. A comparison of these data with the frequency distributions arising from either a constant risk or a normal theory of failure is included, as well as an evaluation of the agreement between theory and data. 42 pp. Illus. Published in the *Journal of the American Statistical Association*, June, 1952. Presented before the American Statistical Association at Washington, D.C., December, 1953.

P-184 (out of print). Forgeable arc-melted tungsten. Battelle Memorial Institute. 10-30-50. Unclassified.

A brief account of experiments which successfully attacked the problem of melting tungsten to form a forgeable ingot. The procedures used and the results obtained are given. 6 pp. Illus. Published in *Metal Progress*, Vol. 59, 1951.

P-187. An experimental study of ambiguity and context. Abraham Kaplan. 11-30-50. Unclassified.

A study of the problem of determining how much and in what ways verbal setting reduces ambiguity in language. 18 pp. Published in the *Research Laboratory of Electronics*, November, 1950.

P-188. On certain games with transcendental values. O. A. Gross. 11-13-50. Unclassified.

An observation that for certain games with transcendental values there is no optimal strategy consisting of a step function of finitely many steps. 2 pp. Published in the *Annals of Mathematics Studies*, No. 28, 1953.

P-189. Optimal inventory policy. K. J. Arrow, T. E. Harris, and J. Marschak. 11-16-50. Unclassified.

An outline of a method for deriving optimal rules for inventory policy. Essentials of the optimal stock determination under conditions of certainty are given, a static model is discussed, and the mathematical problem for a simplified dynamical model is formulated. Methods of solution are given, and the simplified dynamical model is solved. 47 pp. Published in *Econometrica*, July, 1951. Presented before the Cowles Commission at Chicago, Illinois, December 1, 1950.

P-190. A book review of Schlesinger's *Marx, his time and ours*. N. M. Kaplan. 12-13-50. Unclassified.

A review of Rudolf Schlesinger's book, "Marx, His Time and Ours," published in 1950. 3 pp. Also published in *The Journal of Political Economy*, June, 1951.

P-193. A further generalization of the Kakutani fixed-point theorem, with applications to Nash equilibrium points. I. L. Glicksberg. 2-9-51. Unclassified.

A proof of the analogue of the Tychonoff extension of the fixed-point theorem of Brouwer for the Kakutani fixed-point theorem. The Kakutani theorem is extended to convex Hausdorff linear topological spaces. With this, the existence of equilibrium points in the general n -person continuous game, with continuous payoffs, is demonstrated. 8 pp. Published in the *Proceedings of the American Mathematical Society*, February, 1952.

P-194. The lesser evil. W. P. Davison. 3-28-51. Unclassified.

An account from first-hand observations of the attitude of the Korean people toward the United Nations intervention. This paper discusses some of the reasons why Koreans support the UN intervention. 13 pp. Published in *The Reader's Digest*, June, 1951.

P-196. Psychological warfare reconsidered. Hans Speier. 2-5-51. Unclassified.

A discussion of the bases, objectives, and methods of psychological warfare. The "will to fight" is analyzed as applied to the military and the political elites, and the working and the fighting populations. The role of propaganda is examined and some historical examples are cited. 38 pp. Published in *The Policy Sciences*, ed. by Daniel Lerner, Stanford University, Palo Alto, California, 1951. Reprinted in H. Speier, *Social Order and the Risks of War*, George W. Stewart, Publisher, Inc., New York, 1952, and in *Propaganda in War and Crisis*, ed. by Daniel Lerner, George W. Stewart, Publisher, Inc., New York, 1951. Presented before the Air War College, Maxwell Air Force Base, Alabama, 1951.

P-197. Modifications of the RAND REAC. W. S. Melahn. 2-26-51. Unclassified.

A description of the modification made in the RAND electric analogue computer to increase the efficiency of operation. The remote control panel and the IBM-type plugboards are described. 8 pp. Published in the *Proceedings of Project Cyclone Symposium I on REAC Techniques*, March 15-16, 1951. Presented in the Project CYCLONE Symposium on REAC Techniques at Reeves Instrument Co., New York City, March 15-16, 1951.

P-198. Supersonic flow around cones at large yaw. G. B. W. Young and C. P. Siska. 8-6-51. Unclassified.

A presentation of equations for the flow properties in the region bounded by a supersonic cone body at large angle of attack and its attached shock wave (for use with the tabulations of Kopal). 28 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, February, 1952.

P-199. Optimum trajectories. A. S. Mengel. 1-15-51. Unclassified.

A paper on the value of the analogue computer in applied research. Its proven contribution is demonstrated in the study of the application of the calculus of variations to the optimization of aircraft flight paths. 27 pp. See also RM-100. Published in the *Proceedings of Project Cyclone Symposium I on REAC Techniques*, March 15-16, 1951. Presented in the Project CYCLONE Symposium on REAC Techniques at Reeves Instrument Co., New York City, March 15-16, 1951, and before the Association for Computing Machinery at Wayne University, Detroit, Michigan, March 27-28, 1951.

P-200. Taxation and incentive in mobilization. Gershon Cooper. 3-7-51. Unclassified.
An examination of (1) the effects on labor incentive of various possible kinds of change in the income tax structure and (2) the implications of these results for fiscal policy in mobilization. 27 pp. Illus. Published in the *Quarterly Journal of Economics*, February, 1952. Presented before the Econometric Society at Santa Monica, California, August 2, 1951.

P-201. The game of "gossip" analyzed by the theory of information. Edgar Reich. 3-15-51. Unclassified.

A mathematical analysis of a distributed model of the game of "gossip" in which a message is passed through a line of individuals and the final result is compared with the original ungarbled message. 9 pp. Published in the *Bulletin of Mathematical Biophysics*, December, 1951.

P-202. Principles of creep buckling. F. R. Shanley. 7-15-52. Unclassified.

An investigation of (1) a model showing how the gradual buckling of a column may occur because of creep under the action of compressive stresses and (2) the effects of initial eccentricity. 29 pp. Illus. See also R-222 (out of print). Published in *Weight-Strength Analysis of Aircraft Structures*, McGraw-Hill Book Company, Inc., New York, 1952.

● **P-204. A formal theory of the employment relationship.** H. A. Simon. 12-7-50. Unclassified.

A generalized model which incorporates rational grounds for the choice by two individuals between an employment contract and a contract of the ordinary kind (sales contract). 18 pp. Illus. Published in *Econometrica*, July, 1951. Presented before the Cowles Commission at Chicago, Illinois, October 13-14, 1950.

● **P-205 (out of print). Applications of optimum design principles to structural weight estimation.** R. J. Lutz. 4-24-51. Unclassified.

A discussion of the weight problem (in relation to thrust, drag, and lift forces) as it affects airplane performance estimates. 22 pp. Illus. Presented before the Society of Aeronautical Weight Engineers at St. Louis, Missouri, May 21-24, 1951.

P-206. The coefficient of resource-utilization. Gerard Debreu. April 1951. Unclassified.

An attempt to determine numerically the "dead loss" associated with a nonoptimal situation (in the Pareto sense) of an economic system. The treatment is based on vector set properties in the commodity space. 32 pp. Illus. Published in *Econometrica*, July, 1951. Presented before the Econometric Society at Cambridge, Massachusetts, August, 1950.

P-207. First passage and recurrence distributions. T. E. Harris. 12-14-51. Unclassified.

A discussion of first passage and recurrence distributions for the states of an irreducible Markov chain. 26 pp. Published in the *Proceedings of the Institute of Mathematical Statistics*, September, 1951, and in the *Transactions of the American Mathematical Society*, 1952. Presented before the Institute of Mathematical Statistics at the University of Minnesota, Minneapolis, Minnesota, September, 1951.

P-208. Specific industry output projections. H. J. Barnett. 9-1-51. Unclassified.

A report on a conference (held in May, 1951, at RAND) on Research in Income and Wealth. 25 pp. Illus. See commentary P-243. Published in *Studies in Income and Wealth*, Vol. 15, National Bureau of Economic Research, New York, 1953. \$3.50. Presented before the National Bureau of Economic Research Council at New York City, May 26, 1951.

P-210. The generalized approach to the selection of propulsion systems for aircraft. L. R. Woodworth and C. C. Kelber. 5-22-51. Unclassified.

A paper which considers the powerplant in terms of the performance and application requirements for aircraft. 35 pp. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, June 27-28, 1951.

● **P-211 (out of print). Remark on the Minkowski inequality.** J. M. Danskin, Jr. 5-18-51. Unclassified.

A short proof of Minkowski's inequality, proceeding from the concavity of a certain function. 3 pp.

P-212. Drescher's inequality. J. M. Danskin, Jr. 5-18-51. Unclassified.

An elementary proof of an inequality, using the Minkowski inequality and an inequality due to Radon. 5 pp. Published in *The American Mathematical Monthly*, December, 1952.

P-213. On the Hitchcock distribution problem. M. M. Flood. December 1951. Unclassified.

A mathematical procedure for obtaining a solution to a linear programming problem. 26 pp. Published in the *Symposium on Linear Inequalities and Programming*, No. 10, Project scoop, U.S. Air Force, Washington, D.C., April, 1952, and in the *Pacific Journal of Mathematics*, June, 1953. Presented before a conference on Linear Inequalities and Programming at Washington, D.C., June 17-19, 1951.

P-214. The compressible boundary layer. G. B. W. Young and E. Janssen. 6-1-51. Unclassified.

An extension of P-50, "A Solution of the Laminar Boundary Layer Equations for a Compressible Fluid with Variable Properties, Including Dissociation." Solutions are obtained for (1) laminar boundary layer equations in integral form as determined on the mechanical differential analyzer, and (2) Mach numbers ranging from incompressible speeds to the hypersonic regime at ambient temperatures of 100°, 400°, and 800°R for insulated plate and heat transfer cases. 38 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, April, 1952.

• **P-215. Efficiency aspects of dispersal of population and industry.** T. C. Koopmans. 6-5-51. Unclassified.

An analysis of the efficiency aspects of dispersal, defined as a factor which diminishes the damage that can be inflicted by an enemy through a given application of resources to his attack. 14 pp. Presented before a Logistics Conference at RAND, July 7, 1951.

P-216. The Combomat. J. D. Madden. 6-28-51. Unclassified.

A discussion of the Combomat, a system installed at RAND wherein computation jobs may be set up directly for an IBM Card-programmed Electronic Calculator. 10 pp. A condensation of RM-594. Published in the *Proceedings of the Computation Seminar*, August, 1951. Presented before a seminar on IBM computation at Endicott, New York, August 13-17, 1951.

P-217. Methodology for communications research. A. L. George. 8-31-51. Unclassified.

A paper which discusses methodological problems encountered when inferences are made from content about the antecedent conditions of that content. 6 pp. Published in *The Public Opinion Quarterly*, Winter, 1951. Presented at Princeton University, Princeton, New Jersey, June 23, 1951.

• **P-218. Time-dependent stress-strain distributions.** T. P. Higgins, Jr. 6-18-51. Unclassified.

A method to determine the amount of inelastic strain that occurs for nonlinear stress-time variations. The method is applicable to all stages of creep in any load-carrying structure. 18 pp. Illus.

P-219. A comparison of organization theories. H. A. Simon. 5-15-51. Unclassified.

A paper suggesting a framework that permits a comparison of the economist's theory of the firm and the administrator's theory of organizational equilibrium. 21 pp. Published in *The Review of Economic Studies*, January, 1953. Presented before the Cowles Commission at Chicago, Illinois, October 13, 1951.

• **P-220 (out of print). Symmetric three-person games and the concept of an independent point.** R. E. Bellman. 6-20-51. Unclassified.

An examination of symmetric three-person zero-sum games and of the concept of an independent point. 8 pp.

P-222. A comparison of treatments of a duopoly situation. J. P. Mayberry, J. F. Nash, and M. Shubik. 7-10-51. Unclassified.

An examination, on the basis of each of several theories, of the behavior of two firms in competition, with explicit cost functions and an explicit demand function. 21 pp. Illus. Published in *Econometrica*, January, 1953.

- P-223 (out of print). A gradient method for approximating saddle points and constrained maxima. K. J. Arrow and L. Hurwicz. 6-13-51. Unclassified.

A description of a gradient method for approximating saddle points and constrained maxima. 15 pp. Presented before the Econometric Society at Santa Monica, California, August 1951.

- P-225. On the iteration of power series in two variables. R. E. Bellman. 7-5-51. Unclassified.

A discussion of the problem of finding an iteration of a power series in two variables. 14 pp. Published in the *Duke Mathematical Journal*, June, 1952.

- P-226. Some observations on the role of research in political warfare. W. P. Davison. 10-1-51. Unclassified.

A discussion of the activities embraced by the term "political warfare," defined as the planned use of communication, policies, and overt actions to influence the emotions or attitudes of selected publics and thus to affect their behavior in such a way as to further national objectives. 32 pp. Published in the *Journalism Quarterly*, Winter, 1952. Presented before the American Association of Teachers of Journalism at the University of Illinois at Urbana, Illinois, August 28, 1951.

- P-227. Geometry of moment spaces. S. Karlin and L. S. Shapley. 8-20-52. Unclassified.

A study of the geometry of moment spaces with a discussion of distributions having given moments, application to orthogonal polynomials, and symmetries of the moment spaces. 98 pp. Illus. See P-97. Published in the *Memoirs of the American Mathematical Society*, No. 12, 1953.

- P-230. On some dynamic linear programming problems. R. E. Bellman. 8-10-51. Unclassified.

A study of a class of mathematical problems connected with physical situations which require that a finite or unbounded sequence of operations be performed for the purpose of achieving a desired result. 11 pp.

- P-232 (out of print). On the min max of $\int_0^1 f(x)a(x)d(x) dt(x)$. R. E. Bellman and M. Shiffman. 8-21-51. Unclassified.

A formulation of a procedure to determine the min max of $\int_0^1 f(x)a(x)d(x) dt(x)$. 13 pp. Illus.

- P-233. A note on a class of integral equations related to the Bessel and Mathieu functions. R. E. Bellman. 8-24-51. Unclassified.

Some approximate methods for finding the characteristic values of a certain integral equation. 7 pp.

- P-234. On the application of servomechanism theory in the study of production control: a study in the theory of organization. H. A. Simon. 8-15-51. Unclassified.

An application of the servomechanism theory to the analysis and design of decisional procedures for controlling the rate of manufacturing activity. 30 pp. Illus. Published in *Econometrica*, April, 1952. Presented before a Seminar on Communication Theory at Columbia University at New York, April 10, 1951.

- P-235. A game over function space. J. M. Danskin, Jr., and L. Gillman. 2-16-53. Unclassified.

A proof of the existence of a saddle-point in an example of a nonlinear game over function space and a derivation of an explicit formula for the solution. 15 pp. Published in the *Rivista di Matematica della Università di Parma*, Nos. 1-2, Vol. IV, 1953. Presented before the American Mathematical Society at Providence, Rhode Island, December 29, 1951.

- P-236. On the evaluation of noise samples. A. J. F. Siegert. 9-7-51. Unclassified.

A development of some criteria to aid in deciding whether a noise sample can reasonably be assumed to have come from a Gaussian noise with predetermined parameters. 16 pp. Published in the *Journal of Applied Physics*, July, 1952.

P-237. Chemical kinetics and rocket nozzle design. F. J. Krieger. 9-20-51. Unclassified.
An investigation of the effects of chemical kinetics on rocket nozzle design for the case of hydrogen gas flowing adiabatically through a typical rocket nozzle which has a chamber-to-throat area ratio of 2 to 1. The types of flow considered are constant composition (frozen equilibrium), instantaneous chemical equilibrium (shifting equilibrium), and kinetic chemical equilibrium. 25 pp. Published in the *Journal of the American Rocket Society*, November, 1951.

- **P-238. The first passage problem for a continuous Markoff process.** D. A. Darling and A. J. F. Siegert. 3-2-53. Unclassified.

A derivation of certain expressions for the first passage time with two barriers. 31 pp. Published in *The Annals of Mathematical Statistics*, December, 1953.

- **P-239. Comparisons of input-output and alternative projections, 1929-1939.** S. S. Arrow. 4-14-51. Unclassified.

An attempt to compare four alternative techniques of forecasting under the hypothesis that all the basic data necessary for each method are available. The errors are examined in each set of projections of industry outputs from 1929 to 1939. 17 pp. Illus.

P-241. Reduction of certain classes of games to integral equations. Samuel Karlin. 10-9-51. Unclassified.

An investigation of the relationship of certain classes of games with corresponding integral equations. 42 pp. Published in the *Annals of Mathematics Studies*, No. 28, 1953. Presented before the Mathematics Society at Minneapolis, Minnesota, September, 1951.

P-242 (out of print). The Politburo through Western eyes. N. C. Leites. 10-12-51. Unclassified.

A discussion of the image of the Moscow Politburo as presented by *The Economist* between February, 1946, and June, 1950. This image is examined in relation to history and to the author's own construction (see *The Operational Code of the Politburo*, McGraw-Hill Book Company, Inc., New York, 1951). 31 pp. Published in *World Politics*, January, 1952.

- **P-243. Comments on H. J. Barnett's *Specific industry output projections*.** A. W. Marshall. 10-1-51. Unclassified.

A discussion of the appropriateness of comparisons presented in P-208, *Specific Industry Output Projections*, for decisions as to the acceptance or rejection of proposed forecasting methods. An alternative method of measuring the forecasting errors is suggested. 4 pp. Illus. Published in *Long-range Economic Projection: Studies in Income and Wealth*, Vol. 16, *A Report of the National Bureau of Economic Research* by The Conference on Research on Income and Wealth, Princeton University Press, Princeton, New Jersey, 1954. \$9.00. Presented before the National Bureau of Economic Research Conference at New York City, May, 1951.

- **P-244 (out of print). Linear approximations in a class of nonlinear vector differential equations.** J. J. Gilvarry. 10-16-51. Unclassified.

A derivation of linear approximations for a class of nonlinear vector differential equations. 21 pp. Published in the *Quarterly of Applied Mathematics*, July 1953.

- **P-245. An analysis of three-move finite games.** M. Drescher, O. Helmer, and R. A. Wagner. 10-16-51. Unclassified.

A discussion of three-move finite games, with formulas for values from which methods of solution can be obtained. 9 pp. Illus.

P-246. Temperatures and motions of the upper atmosphere. W. W. Kellogg. 11-17-51. Unclassified.

A paper which reviews methods of obtaining data on the upper atmosphere. A dynamic model of the atmosphere up to about 120 km is constructed to explain seasonal and latitudinal variations in the upper atmosphere. In addition, current estimates of conditions above 120 km are discussed. 28 pp. Illus. Published in *Physics and Medicine of the Upper Atmosphere*, ed. by C. S. White and O. O. Benson, University of New Mexico Press, Albuquerque, New Mexico, 1952. \$10.00. Presented before the Symposium of Medicine and Physics of the Upper Atmosphere at San Antonio, Texas, November 6-9, 1951.

P-247. Definite and semidefinite quadratic equations. Gerard Debreu. 9-6-51. Unclassified.

Original proofs for the conditions that a quadratic form be definite or semidefinite, with or without linear constraints. 9 pp. Published in *Econometrica*, April, 1952.

P-248. The theory of infinite games. Samuel Karlin. 10-18-51. Unclassified.

A development of the general theory of infinite games, with a presentation of some new examples of determinate games. 53 pp. Published in the *Annals of Mathematics Studies*, No. 28, 1953.

P-249. The current and predicted status of engineering techniques in relation to human travel at upper altitudes. R. M. Salter. 11-1-51. Unclassified.

A study of the current and predicted status of engineering techniques related to human travel in the upper atmosphere. The "how" and "when" of manned space flight are discussed, together with the reasons for human participation in such a venture. 11 pp. Published in *Physics and Medicine of the Upper Atmosphere*, ed. by C. S. White and O. O. Benson, University of New Mexico Press, Albuquerque, New Mexico, 1952. \$10.00. Presented before the Symposium of Medicine and Physics of the Upper Atmosphere at San Antonio, Texas, November 6-9, 1951.

• **P-251. An econometric model of interindustry material flows.** R. W. Shephard. 11-15-51. Unclassified.

An analysis of economic relations in terms of which a statistical study may be made of changes in the material flow coefficients of the Leontief input-output model from 1929 to 1949. 27 pp. Presented before the Econometric Society at Boston, Massachusetts, December 26-29, 1951.

P-252. Moment spaces and inequalities. M. Dresher. 10-7-52. Unclassified.

A geometrical interpretation of an integral inequality as a condition that a given point lie in a space defined by the convex hull of a given curve. By characterizing the boundaries of various dimensions, integral inequalities are derived from the requirement that points of the space lie within elements of the boundaries. 22 pp. Published in the *Bulletin of the American Mathematical Society*, March, 1952, and in the *Duke Mathematical Journal*, June, 1953. Presented before the American Mathematical Society at Providence, Rhode Island, December 27, 1951.

P-254. On a class of games. Samuel Karlin. 11-16-51. Unclassified.

A qualitative description of the nature of optimal strategies for a payoff kernel satisfying a certain condition on its partial derivatives. 13 pp. Published in the *Annals of Mathematics Studies*, No. 28, 1953.

P-255. Solutions of convex games as fixed-points. M. Dresher and S. Karlin. 11-12-51. Unclassified.

A derivation of some general dimensional properties of solutions for games played over arbitrary convex sets, using a fixed-point interpretation of an optimal strategy. 16 pp. Published in the *Annals of Mathematics Studies*, No. 24, 1950. Presented before the International Congress of Mathematicians at Cambridge, Massachusetts, August 30-September 6, 1950.

• **P-256. A preference experiment.** M. M. Flood. 11-13-51. Unclassified.

A study of a preference experiment conducted to develop a theory adequate to predict (1) the group preference in any single trial, in terms of data available prior to the trial, and (2) the interesting features of group activity encountered in the choice process. The experiment described consists in a group of individuals asked to select one from a set of alternatives. 43 pp. Illus. See also P-258, P-263, P-312, P-346, RM-709, and RM-789-1. Published in the *Proceedings of a Conference on Mathematical Models and Human Behavior*, Rye, New York, February 26-27, 1954. Presented before a seminar on the Design of Experiments at Santa Monica, California, June 25, 1952, and before a conference on Mathematical Models and Human Behavior at Rye, New York, February 26-27, 1954.

P-257. Games of pursuit. R. P. Isaacs. 11-17-51. Unclassified.

A discussion of several examples of games of pursuit. 14 pp. Illus. Published in the *Bulletin of the American Mathematical Society*, January, 1953. Presented before the American Mathematical Society at Los Angeles, California, November 29, 1952, and before the Operations Research Society of America, held at Cleveland, Ohio, May, 1953.

- **P-258. A preference experiment.** M. M. Flood. 12-5-51. Unclassified.

A report on the first trial in the second series of experiments of a type discussed in P-256, *A Preference Experiment*. This study attempts to develop and test theories of organization relevant to predictions of the expected outcome of the trial. The experiment described is one in which a group of subjects is required to select one from eleven objects and to dispose of it among themselves. 42 pp. Illus. See also P-263, P-312, P-346, RM-709, and RM-789-1. Published in the *Proceedings of a Conference on Mathematical Models and Human Behavior*, Rye, New York, February 26–27, 1954. Presented before a seminar on the Design of Experiments at Santa Monica, California, June 25, 1952, and before a conference on Mathematical Models and Human Behavior at Rye, New York, February 26–27, 1954.

- **P-259. A quantitative analysis of two proposed mechanisms for vertical ozone transport in the lower stratosphere.** W. W. Kellogg. 12-17-51. Unclassified.

An examination of two processes (turbulent mixing and large-scale meridian circulation) for downward transport of ozone in the stratosphere. 3 pp. Published in the *Journal of Meteorology*, December, 1952.

- **P-260. Reliability of estimates of unfree labor in the USSR.** A. D. Redding. 1-2-52. Unclassified.

An analysis of the Jasny article on the size of the Russian unfree labor force, "Labor and Output in Soviet Concentration Camps" (*The Journal of Political Economy*, October, 1951). In particular, the crucial role which conjecture plays in his discussion and the errors in his interpretation of data in the 1941 Plan are examined. 7 pp. Published in *The Journal of Political Economy*, August, 1952.

- **P-261. Physical properties of the atmosphere between ~ 80 km and ~ 250 km.** H. K. Kallmann. 1-4-52. Unclassified.

A study of the essential features (total pressure, mean molecular weight, mean density, and average particle density) of the atmosphere between ~ 80 km and ~ 250 km. 6 pp. Illus. Published in the *Journal of Geophysical Research*, June, 1953. Presented before the Meteorological Section of the American Geophysical Union at the California Institute of Technology, Pasadena, California, February 9, 1952.

- **P-262 (out of print). A simple type of game over function space, convex for the minimizing player.** J. M. Danskin, Jr., and W. H. Fleming. 1-8-52. Unclassified.

A discussion of a game over function space in which there is a pure strategy solution for the minimizing player and a mixed strategy solution for the maximizing player. 5 pp.

- **P-263. A preference experiment.** M. M. Flood. 1-25-52. Unclassified.

A report on trials 2, 3, and 4 of a preference experiment described in P-256 and P-258. The trials were concerned with non-zero-sum game theory and closely related mathematical theories relating to group decision processes; variations were introduced in these trials by using experienced subjects and by using chances to obtain objects. 24 pp. See also P-312, P-346, RM-709, and RM-789-1. Published in the *Proceedings of a Conference on Mathematical Models and Human Behavior*, Rye, New York, February 26–27, 1954. Presented before a seminar on the Design of Experiments at Santa Monica, California, June 25, 1952, and before a conference on Mathematical Models and Human Behavior at Rye, New York, February 26–27, 1954.

- **P-265. Equivalence of information patterns and essentially determinate games.** N. C. Dalkey. 2-20-52. Unclassified.

Derivations of a necessary and sufficient condition for the equivalence of information patterns in general games and of a necessary and sufficient condition for essential determinateness. 33 pp. Illus. Published in the *Annals of Mathematics Studies*, No. 28, 1953.

- **P-266. The uses and limitations of mathematical models, game theory, and systems analysis in planning and problem solution.** J. L. Kennedy. 2-11-52. Unclassified.

A discussion of how to deal scientifically with a complex system; i.e., "an assemblage of objects united by some form of regular interaction or interdependence, an organic or organized whole."

21 pp. Published in *Psychology in the World Emergency*, University of Pittsburgh Press, Pennsylvania, 1952. \$4.00. Presented before the Symposium on Current Trends in Psychology at the University of Pittsburgh, Pennsylvania, February 15, 1952.

● **P-267. Use of the learning curve.** David Novick. 11-9-51. Unclassified.

A discussion of the learning curve (a concept of estimating changes in unit labor cost as increasing quantities of an article are produced) and of some of the things to be considered in using the curve for prediction purposes. 6 pp. Tables.

P-269. The Soviet concept of economic regionalization. Theodore Shabad. 2-19-52. Unclassified.

An attempt to clarify the Soviet concept of economic regionalization. The underlying principles of Soviet regionalization and the criteria shaping the economic regions in the USSR are considered. In addition, the extent to which the tools of Western regional analysis are applicable to the Soviet concept and practice is discussed. 12 pp. Published in *Geographical Review*, April, 1953. Presented before the International Geographic Congress at Washington, D.C., August, 1952.

P-270. International political communication: elite versus mass. Hans Speier. 2-15-52. Unclassified.

A discussion of a few specific political conditions without which international communications cannot possibly result in desirable action. Particular reference is made to the measure of control that can be exercised over politically relevant actions by the communicating and the receiving powers, respectively. 18 pp. Published in *World Politics*, April, 1952. Presented before the American Sociological Society at Chicago, Illinois, September, 1951.

● **P-271. Ordered vector spaces.** M. Hausner and J. G. Wendel. 2-22-52. Unclassified.

A proof that any ordered vector space is a subspace of an ordered vector space of a canonical kind. 10 pp. Published in the *Proceedings of the American Mathematical Society*, December, 1952. Presented before the American Mathematical Association at Eugene, Oregon, June 22, 1952.

● **P-272. Some practical problems of the alertness indicator.** J. L. Kennedy. 2-29-52. Unclassified.

An attempt to evaluate various methods of warning personnel of impending unalertness. 9 pp. Published in *Fatigue*, ed. by Floyd and Welford, H. K. Lewis & Co., Ltd., London, England, 1953. 12s (about \$1.70). Presented before the Ergonomics Research Society at Cranfield, England, April 3, 1952.

● **P-273. The what and the how are both essential to munitions production.** David Novick. 3-3-52. Unclassified.

A discussion of the problem of U.S. preparedness. Can the marriage between those who know how to produce and those who know what to produce be postponed in this atmosphere short of war or are the satisfactory results to be achieved by the common-law living together which the cold war requires? 7 pp.

● **P-274. Thermal stresses in a partially clamped elastic half-plane.** J. H. Huth. 3-10-52. Unclassified.

A method is presented for analyzing stress singularities to serve as a guide for numerical studies of problems in the theory of elasticity. 11 pp. Illus. Published in the *Journal of Applied Physics*, December, 1952.

P-276. Trends in Soviet industrial productivity. Walter Galenson. 3-6-52. Unclassified.

A paper which examines past trends in Soviet industrial productivity, compares absolute productivity levels in Soviet and American industry, and suggests possible productivity trends in the Soviet Union during the next two decades. 27 pp. Illus. Published in *Soviet Economic Growth*, ed. by Abram Bergson, Row, Peterson & Co., Evanston, Illinois, 1953. \$6.00. Presented before a meeting at Arden House, Harriman, New York, May 23-25, 1952.

P-278. Soviet agricultural prospects. J. A. Kershaw. 3-7-52. Unclassified.

One of several studies of the Soviet economy. The present paper speculates on the way the relevant magnitudes of economic effort (e.g., industry and agriculture) are likely to interact and attempts to describe a probable economic structure of Soviet agriculture in 1970. 22 pp. Published in *Soviet Economic Growth*, ed. by Abram Bergson, Row, Peterson & Co., Evanston, Illinois, 1953. \$6.00. Presented before a meeting at Arden House, Harriman, New York, May 23-25, 1952.

- **P-280. On the asymptotic efficiency of certain nonparametric two-sample tests.** A. M. Mood. 3-17-52. Unclassified.

The computation of certain asymptotic efficiencies for given two-sample tests against normal alternatives to the null hypothesis. 17 pp. Published in *The Annals of Mathematical Statistics*, September, 1954. Presented before the Institute of Mathematical Statistics at Stanford University, Palo Alto, California, June 20, 1953.

P-282. Efficient transportation in networks. Martin Beckmann. 3-19-52. Unclassified.

A study of the efficient allocation of moving transportation equipment (vehicles) in a given network of highway lanes or railroads of limited road capacity. 5 pp. Published in the *Minutes of the Third Annual Logistics Conference*, January, 1952. Presented before the Logistics Conference at Washington, D.C., January, 1952.

P-287. The "policy sciences": aspiration and outlook. Paul Kecskemeti. 4-1-52. Unclassified.

A study which defines the term "policy sciences" and traces its development. The main methodological principle involved in the concept is discussed, together with the problem of relating theory and practice in the social and political field. 25 pp. Published in *World Politics*, July, 1952.

P-288. Transportation. J. H. Blackman. 12-17-52. Unclassified.

A discussion of the magnitude and nature of the transport services required by the Soviet economy to evaluate certain measures of traffic and, thereby, to determine current levels of activity. Long-term growth prospects of transportation are analyzed to explore the implications of various hypothesized levels of production. 47 pp. Illus. Published in *Soviet Economic Growth*, ed. by Abram Bergson, Row, Peterson & Co., Evanston, Illinois, 1953. \$6.00. Presented before a meeting at Arden House, Harriman, New York, May 23-25, 1952.

P-289. Trends and prospects of the Soviet population and labor force. W. W. Eason. 12-17-52. Unclassified.

A discussion of the trends and prospects in Soviet labor supply as indicated by changes in the sex and rural-urban structure of the working age population, and by the emergence of predominantly industrial-type labor force requirements. The time periods considered are: 1926-39, 1939-50, and 1950-70. 79 pp. Illus. Published in *Soviet Economic Growth*, ed. by Abram Bergson, Row, Peterson & Co., Evanston, Illinois, 1953. \$6.00. Presented before a meeting at Arden House, Harriman, New York, May 23-25, 1952.

P-290. A continuous model of transportation. Martin Beckmann. 3-25-52. Unclassified.

A study of commodity flows in terms of vector fields. Efficient transportation gives rise to a problem in the calculus of variations; the flow functions solving this problem contain price distribution functions as parameters. With net production functions dependent on prices, the model considered describes the flows and prices in a competitive regional market economy. 27 pp. Illus. Published in *Econometrica*, October, 1952. Presented before the Econometric Society at Minneapolis, Minnesota, September 5, 1951.

- **P-291. An example in the theory of organization.** Allen Newell. 2-14-51. Unclassified.

An attempt to crystallize some of the thinking on organization theory by constructing a simple but well-defined situation which can be organized in various ways. 2 pp. Presented before the Cowles Commission Seminar at the University of Chicago, Chicago, Illinois, May 18, 1951.

- **P-292. Abstract: proofs of the law of diminishing returns.** P. A. Samuelson. 2-23-51. Unclassified.

An examination of the deductive errors in reasoning that pervade attempts in literature to derive the law of diminishing returns in one of its many forms. 2 pp.

- P-293. An extension of the Brown-Robinson iterative process for finding the value of a game. J. M. Danskin, Jr. 4-9-52. Unclassified.

A proof that the process corresponding to the Brown-Robinson iterative method is valid for zero-sum two-person games with continuous payoffs, played over the unit square. 13 pp. Published as "Fictitious Play for Continuous Games" in the *Naval Research Logistics Quarterly*, December, 1954. Presented before the American Mathematical Society at St. Louis, Missouri, December 29, 1952.

- P-294. Applications of the Kac-Siebert method for finding output probability densities for receivers with square law detectors. R. C. Emerson. 4-14-52. Unclassified.

A discussion of the Kac-Siebert method for finding the output probability density characteristic function for receivers with square law envelope detectors. A parallel development is given for the square law rectifier. In addition, procedures are outlined for determining the probability density functions directly. 31 pp. Illus. Published in the *Journal of Applied Physics*, September, 1953. Presented before the Institute of Radio Engineers at Long Beach, California, August, 1952.

- P-295. A value for n -person games. L. S. Shapley. 3-18-52. Unclassified.

An examination of a number of elementary properties of a value for the "essential" case. This value is deduced from a set of three axioms, having simple intuitive interpretations. 15 pp. Illus. Published in the *Annals of Mathematics Studies*, No. 28, 1953.

- P-296. Hypothetical robots and the problem of neuroeconomy. J. T. Culbertson. 4-22-52. Unclassified.

A study of general methods for constructing robots. The need to find more economical methods of construction (fewer neurons) is discussed. 58 pp. Illus. See companion piece P-316. Incorporated in *Automata*, ed. by C. Shannon and J. McCarty, Princeton University Press, Princeton, New Jersey. \$4.00. Presented before the Institute of Radio Engineers at the University of California at Los Angeles, May 14, 1952.

- P-297. Quota solutions of n -person games. L. S. Shapley. 4-7-52. Unclassified.

A presentation of a family of solutions for a class Q ("quota games") of n -person games which embraces all constant-sum four-person games and a not inconsiderable array of higher games. In addition, some related, more complicated solutions to Q games are described with an extension of the earlier results to a wider class of games. 24 pp. Illus. Published in the *Annals of Mathematics Studies*, No. 28, 1953.

- P-298. Comments on Solow "Structure of linear models." I. N. Herstein. 4-28-52. Unclassified.

A simplification by Wielandt, and by Debreu and Herstein, of several of the Solow proofs involving some results about the characteristic roots of indecomposable nonnegative matrices which are due to Frobenius. 3 pp. Published in *Econometrica*, October, 1952.

- P-301. Are we sure about dispersal? G. Cooper and R. N. McKean. 5-19-52. Unclassified.

A preliminary appraisal of dispersal policy. Certain of its social objectives are discussed, and several alternatives to dispersal are indicated. 29 pp. See companion study P-548.

- P-302. Emotional stress and air war. A. L. George. 5-27-52. Unclassified.

A lecture describing the RAND investigation of the types of emotional stress likely to arise in U.S. and Allied populations under the threat and actuality of air bombing. A summary of work presented in R-212 (out of print). 27 pp. Presented before the Air War College at Montgomery, Alabama, November 28, 1951.

- P-303. A social equilibrium existence theorem. Gerard Debreu. 4-24-52. Unclassified.

A presentation of the existence theorem giving general conditions for a social system in which there is an equilibrium, i.e., a situation where the action of every agent belongs to his restricting subset and no agent has incentive to choose another action. 11 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, October, 1952.

- **P-304. Thermal stresses in conical shells.** J. H. Huth. 6-12-52. Unclassified.

An analysis of the stresses in a conical shell of revolution resulting from aerodynamic pressure and thermal gradients. This study is applicable to the conical tip of a missile flying at zero angle of attack. 13 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, September, 1953.

- P-305. On the detection of a sine wave in Gaussian noise.** E. Reich and P. Swerling. 6-11-52. Unclassified.

A study to determine the optimum method of detecting a sine wave of known frequency and amplitude in the presence of noise. The type of noise considered is the so-called stationary Gaussian process, which is obtained when thermal noise is passed through an arbitrary linear passive device. 27 pp. Illus. Published in the *Journal of Applied Physics*, March, 1953.

- **P-306. New currents in an old stream.** F. B. Thompson. 7-2-52. Unclassified.

A simple explanation of some of the notions of game theory as an example of new developments in mathematics. 10 pp. Presented before the Institute for Teachers of Mathematics at the University of California at Los Angeles, July 2, 1952.

- P-307. Spontaneous fission versus alpha decay.** Arnold Kramish. 7-2-52. Unclassified.

An analysis of alpha decay and spontaneous fission as closely related, competitive decay processes for heavy nuclei. 3 pp. Illus. Published in *The Physical Review*, December 1, 1952.

- **P-308 (out of print). Activity analysis and the prediction of traffic flows.** M. Beckmann and C. B. McGuire. 7-10-52. Unclassified.

An attempt to examine the efficient utilization of a given highway network and to show that it defines a method for predicting the reaction of traffic to a small change in the network. This study, described in terms of a mathematical model, is related to the broader problem of resource allocation. 3 pp.

- **P-309. A survey of input-output research.** R. W. Shephard. 7-17-52. Unclassified.

An attempt to evaluate (1) the present state of input-output data and (2) the concepts and work effort in this field. In addition, the second edition of Leontief's *The Structure of American Economy 1919-1939* is discussed, together with other literature. 80 pp. Presented before the Conference on National Income at New York City, December, 1952.

- **P-310. Numerical representations of technological change.** Gerard Debreu. 8-4-52. Unclassified.

A formal description of an economic system. The present study considers (1) the wide range for interpreting this model and some of its limitations, (2) technological change and its numerical representation, and (3) a calculus study. 17 pp. Illus. Published in *Metroeconomica*, August, 1954. Presented before a conference on the Quantitative Description of Technological Change at Princeton, New Jersey, April 6-18, 1952.

- P-311. An application of Markov processes to the study of the epidemiology of mental disease.** A. W. Marshall and H. Goldhamer. 9-21-54. Unclassified.

A presentation of several methods (developed in studies of mental disease) for determining certain epidemiological parameters that are not directly observable or that can be secured only by expensive and time-consuming field surveys. 51 pp. Tables. Published in the *Journal of American Statistical Association*, March, 1955. Presented before the Institute of Mathematical Statistics at Ann Arbor, Michigan, September 2, 1952.

- **P-312. Testing organization theories.** M. M. Flood. 11-1-52. Unclassified.

An examination of several descriptive theories and pilot experiments to determine their range of applicability in behavioral situations. 21 pp. See also P-256, P-258, P-263, P-346, RM-709, and RM-789-1. Published in the *Transactions of the New York Academy of Sciences*, February, 1954. Presented before the Institute of Mathematical Statistics and the Econometric Society at East Lansing, Michigan, September 2, 1952, and before the American Society of Mechanical Engineers at Columbus, Ohio, May, 1953.

P-314. The RAND collection of illustrative approximations. C. Hastings, Jr. 8-7-52. Unclassified.

A discussion of the RAND collection of illustrative approximations to a number of the higher transcendental functions. 2 pp. Published in *Mathematical Tables and Other Aids to Computation*, October, 1952.

P-315. Reliability in guided missile systems. R. R. Carhart. 7-7-52. Unclassified.

An attempt to discuss the technical problem of achieving and maintaining optimum reliability in guided missile systems (including both men and machines). The reliability of a given component or system is defined as the probability that it will perform its required function under operational conditions for a specified operating time. 15 pp. Published in the *Aeronautical Engineering Review*, February, 1953. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, November 6, 1952.

● **P-316. Even in memoryless robots there is no small number of central cells sufficient for all input-output specifications.** J. T. Culbertson. 8-12-52. Unclassified.

An extension of a problem (investigated in P-296, "Hypothetical Robots and the Problem of Neuroeconomy") of finding an upper bound to the number of central cells required for any input-output specifications. The present study shows that even in a memoryless robot some specifications require approximately 2^n cells and that no significant economies can be achieved by assigning more complex properties to the synapse. 9 pp. Presented before the Institute of Radio Engineers at the University of California at Los Angeles, April 9, 1953.

● **P-317. Analytical approximations.** C. Hastings, Jr. 8-12-52. Unclassified.

A list of several items on useful working approximations for publication. 2 pp. See P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1953.

● **P-318. Nonnegative square matrices.** G. Debreu and I. N. Herstein. 8-11-52. Unclassified.

A study of square matrices (previously investigated by Perron, Frobenius, and Wielandt) in connection with the theory of resource allocation. This report demonstrates, in addition to other proofs, the basic properties of nonnegative indecomposable matrices and derives general nonnegative square matrices. 17 pp. Published in *Econometrica*, October, 1953. Presented before the American Mathematical Society at St. Louis, Missouri, December 28, 1952.

● **P-319. An axiomatic approach to measurable utility.** I. N. Herstein and J. W. Milnor. 8-12-52. Unclassified.

A simple proof of the existence of a measurable utility. Axiom sets (differing from those of von Neumann, Morgenstern, Marschak, and Rubin) are considered which remove topological considerations of the prospect space itself and allow an infinite number of sure prospects. 10 pp. Published in *Econometrica*, April, 1953. Presented before the Econometric Society at East Lansing, Michigan, September, 1952.

P-321 (out of print). University of Michigan-RAND summer session papers. University of Michigan-RAND Personnel. September 1952. Unclassified.

A collection of papers from the summer seminar on design of experiments on decision processes. 118 pp.

P-322. A random walk related to the capacitance of the circular-plate condenser. Edgar Reich. 9-2-52. Unclassified.

A proof that the solution of a certain class of integral equations (among them the equation of Love for the circular-plate condenser) can be expressed in terms of the mean duration of a one-dimensional random walk with absorbing barriers. 8 pp. Published in the *Quarterly of Applied Mathematics*, October, 1953. Presented before the American Mathematical Society at Los Angeles, California, November, 1952.

● **P-323. Polynomial-like approximation.** O. A. Gross. 9-5-52. Unclassified.

A study to determine (for computing purposes) approximate representation of continuous real-valued functions of several real variables by finite sums of functions separable in the individual variables. 6 pp. Published in *Mathematical Tables and Other Aids to Computation*, April, 1954.

P-325. Depreciation, replacement, and growth. E. D. Domar. 9-11-52. Unclassified.

A discussion of the growth of investment and of a capital stock subject to depreciation and periodic replacement. 54 pp. Illus. Published in *The Economic Journal*, March, 1953.

P-326. Suboptimization in operations problems. C. J. Hitch. 11-18-52. Unclassified.

An analysis of the possibilities, limitations, and dangers of suboptimizing. In addition, the utility of certain concepts and postulates of economic theory for improving the selection of criteria in operations research problems is examined. 24 pp. Illus. See supplement P-386. Published in *Operations Research for Management*, ed. by J. F. McCloskey and F. N. Trefethen, The Johns Hopkins Press, Baltimore, 1954, \$7.50; and in the *Journal of the Operations Research Society of America*, May, 1953. Presented before the National Bureau of Standards at Washington, D.C., November 17-18, 1952.

● **P-327. Employment and labor productivity in USSR railroads, 1928-1950.** A. D. Redding. 9-15-52. Unclassified.

A descriptive survey of employment, traffic volume, and labor productivity in USSR railroads from 1928-1950. Thus, certain railroad time series (culled from a variety of official and semi-official Soviet sources) are determined. 31 pp. Illus. Published in *Soviet Studies*, July, 1953.

P-328. A Bayes model in sequential design. S. M. Johnson and S. Karlin. 1-4-54. Unclassified.

A study to determine the optimal procedure for maximizing the expected number of successes in a given number of trials. 30 pp. Published as "On Sequential Designs for Maximizing the Sum of n Observations" in *The Annals of Mathematical Statistics*, December, 1956.

● **P-329. On a functional equation occurring in the theory of dynamic programming.** R. E. Bellman. 9-30-52. Unclassified.

A discussion of a functional equation which arises in connection with dynamic programming problems involving nonlinear utility functions. 23 pp.

P-330. Analytical approximations, volume II. C. Hastings, Jr. 9-24-52. Unclassified.

A supplement to P-317 of the same title. 7 pp. See also P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1953.

● **P-331. The logical structure of the utility concept.** H. G. Bohnert. 9-29-52. Unclassified.

A discussion which attributes the neutralization of the utility concept to certain infirmities in its logical skeleton, not to its psychological character. This study attempts to analyze rational individual decision on the basis of a "pleasurelike" concept. 20 pp. Published in *Decision Processes*, ed. by R. M. Thrall, C. H. Coombs, and R. L. Davis, John Wiley & Sons, Inc., New York, 1954. \$5.00.

P-332. Arithmancy, theomancy, and the Soviet economy. N. M. Kaplan. 3-6-53. Unclassified.

A review and critique of the Jasny estimates of real Soviet national product and its allocations. 36 pp. Illus. Published in *The Journal of Political Economy*, April, 1953.

● **P-335. Activity analysis of technological structures in production: an example.** Stanley Reiter. 10-15-52. Unclassified.

A continuation of an activity analysis study of production and allocation in which certain parts of technology (activities) are explicitly identified, and with which specific decision variables (activity levels) are associated. The present report formulates a sectorwise additive model and illustrates its application. 12 pp. Illus. Published in *The Review of Economic Studies*, Vol. XX, No. 53, 1952-53.

P-336. Multidimensional utilities. Melvin Hausner. May 1953. Unclassified.

A generalization of the von Neumann and Morgenstern theory of utility, by omission of the Archimedean postulate, and an extension to the infinite-dimensional case. 22 pp. Presented before the Michigan Conference on Utilities at Santa Monica, California, August, 1952.

P-337. Methods of reducing sample size in Monte Carlo computations. H. Kahn and A. W. Marshall. 8-18-53. Unclassified.

A paper which formulates the general problem of Monte Carlo computations within the framework of mathematical statistics and indicates briefly its relation to the theory of estimation and the design of experiments. 18 pp. Published in the *Journal of the Operations Research Society of America*, November, 1953. Presented before the Operations Research Society at Washington, D.C., November 17, 1952.

• **P-338. On maximizing an integral with a side condition.** R. C. Emerson. July 1953. Unclassified.

Calculations to determine an admissible function which makes a specified integral an absolute maximum, subject to special side conditions. 8 pp. Published in the *Proceedings of the American Mathematical Society*, April, 1954.

• **P-339. Transient response of Butterworth approximations of ideal low-pass filters.** Edgar Reich. 10-24-52. Unclassified.

A calculation of step-function responses of low-pass, high-order, Butterworth filters. 9 pp. Illus.

P-340. Analytical approximations, volume III. C. Hastings, Jr. 10-30-52. Unclassified.

A supplement to P-317 and P-330 of the same title. 5 pp. See also P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, July, 1953.

• **P-341 (out of print). On some variational problems occurring in the theory of dynamic programming.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 11-7-52. Unclassified.

Superseded by P-380 of the same title.

• **P-343 (out of print). Relativity precession of minor planets.** J. J. Gilvarry. 11-12-52. Unclassified.

A study of the possibility of basing an observational check of the general relativity result for planetary recession on the motion of minor planets of high eccentricity. In particular, the motion of (1566) Icarus is considered. 14 pp. Illus. Published in the *Publications of the Astronomical Society of the Pacific*, August 1953.

P-344. A note on primitive matrices. I. N. Herstein. 11-12-52. Unclassified.

A simple proof of the condition under which all elements of some power of A are strictly positive. It is assumed that A is a square matrix consisting of nonnegative elements. 5 pp. Published in *The American Mathematical Monthly*, January, 1954.

P-345. The influence of environmental nonstationarity in a sequential decision-making experiment. M. M. Flood. 11-17-52. Unclassified.

A report on various pilot experiments in an attempt to determine the effect on human decision-making of a belief that the environment is changing when in reality it is constant. 30 pp. Illus. Published in *Decision Processes*, ed. by R. M. Thrall, C. H. Coombs, and R. L. Davis, John Wiley & Sons, Inc., New York, 1954. \$5.00. Presented before the University of Michigan Summer Conference on Design of Experiments on Decision Processes, Santa Monica, California, June, 1952.

• **P-346. On game-learning theory and some decision-making experiments.** M. M. Flood. 11-17-52. Unclassified.

A report on games in which a player learns to improve his strategy during the course of a sequence of plays. 39 pp. Illus. See also P-256, P-258, P-263, P-312, RM-709, and RM-789-1. Published in

Decision Processes, ed. by R. M. Thrall, C. H. Coombs, and R. L. Davis, John Wiley & Sons, Inc., New York, 1954. \$5.00. Presented before the University of Michigan Summer Conference on Design of Experiments on Decision Processes, Santa Monica, California, June, 1952.

P-348. Analytical approximations, volume IV. C. Hastings, Jr., and J. P. Wong, Jr.
11-24-52. Unclassified.

A supplement to P-317, P-330, and P-340 of the same title. 5 pp. See also P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, July, 1953.

● **P-350. A theory of fatigue based on unbonding during reversed slip.** F. R. Shanley.
5-1-53. Unclassified.

A general discussion of fatigue (a progressive unbonding of atoms as a result of reversal of slip caused by cyclic loading). 89 pp. Illus. See P-350 supplement, an interim study in which some of the more important recent developments in the theory of fatigue are discussed. 25 pp. Illus. See also RM-1127 and RM-1198.

P-351. The radiative opacity of stellar matter. Harold Zirin. 12-9-52. Unclassified.

An attempt to predict (on the basis of present physical theory) the state of various atoms in stellar gas in order to determine tables for the opacity of stellar material under different conditions. 101 pp. Illus. Published in *The Astrophysical Journal*, March, 1954. Presented before the American Astronomical Society at Amherst, Massachusetts, December 28-31, 1952.

P-352. Activity analysis and its applications. T. C. Koopmans. 12-10-52. Unclassified.

An expository paper on activity analysis and its applications. 14 pp. Published in the *Papers and Proceedings of the American Economic Association*, May, 1953. Presented before the American Economic Association and the Econometric Society at Chicago, Illinois, December 28, 1952.

● **P-353. On stochastic learning theory.** M. M. Flood. 12-19-52. Unclassified.

A discussion of the stochastic learning theory with particular reference to a case in which there are only two classes of events. This paper attempts to narrow the class of allowable matrices M^rs by making an additional reasonable assumption. 24 pp. Published in the *Transactions of the New York Academy of Sciences*, February, 1954. Presented before a Seminar on Content and Methods in the Social Sciences at Columbia University at New York City, February, 1953, and before the Institute of Mathematical Statistics at Washington, D.C., December 27, 1953.

● **P-354. Conflicts with imprecise payoffs.** J. D. Williams. 12-15-52. Unclassified.

A discussion of game theory to illustrate conflict situations in which imprecise payoffs appear. 13 pp. Presented before the American Association for the Advancement of Science at St. Louis, Missouri, December 29, 1952.

P-355. Analytical approximations, volume V. C. Hastings, Jr., and J. P. Wong, Jr.
12-22-52. Unclassified.

One of several papers on useful working approximations. 6 pp. See also P-317, P-330, P-340, P-348, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, July, 1953.

● **P-356. A survey of automatic computers: analog and digital.** W. F. Gunning.
12-23-52. Unclassified.

A discussion of some of the computer techniques, not as yet in wide use, in the field of instrumentation and control engineering. 45 pp. Illus.

P-357. A classical tax-subsidy problem. Gerard Debreu. 12-15-52. Unclassified.

A discussion of a classical tax-subsidy problem in an economic system in which l commodities are transformed into each other by n production-units and consumed by m consumption-units. 15 pp. Published in *Econometrica*, January, 1954. Presented before the Econometric Society at Minneapolis, Minnesota, September 6, 1952.

P-358. Analytical approximations, volume VI. C. Hastings, Jr., and J. P. Wong, Jr. 12-31-52. Unclassified.

Part VI of a larger study on useful working approximations. 8 pp. See also P-317, P-330, P-340, P-348, P-355, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, July, 1953.

P-359. Constant-strain waves in strings. J. D. Cole, C. B. Dougherty, and J. H. Huth. 1-12-53. Unclassified.

A discussion of a nonlinear theory, developed for constant-strain waves in elastic strings. The speed of longitudinal and transverse waves is related to the strain and tension, and from these results the tension due to impact and breaking loads is calculated. 12 pp. Illus. Published in the *Journal of Applied Mechanics*, December, 1953. Presented before the Applied Mechanics Conference at Los Angeles, California, June, 1953.

P-360. Attitudes toward the use of force. Bernard Brodie. 12-4-53. Unclassified.

Digression on international conflict and the use of force. 20 pp. Published in the *Conference Proceedings of the Institute of World Affairs*, December, 1952. Presented before the Institute of World Affairs at Riverside, California, December 17, 1952.

P-361. A method of estimating the compressive strength of optimum sheet-stiffener panels for arbitrary material properties, skin thickness, and stiffener shapes. W. R. Micks. 2-24-53. Unclassified.

A study of a simple method for estimating the strength properties of optimum-designed sheet-stiffener panels made of any material, containing any specified fraction of the panel material in the skin, and having any shape of stiffeners. 37 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, October, 1953. Presented before a Seminar in Structures at the University of California at Los Angeles, January, 1953.

P-363. RAND's digital computer effort. W. F. Gunning. 2-23-53. Unclassified.

A study of various points of interest concerning the digital computer at RAND and its modified version. 7 pp. Published in *A Summary of the Minutes of the Applied Mathematics Advisory Council Meeting*, January 16, 1953. Presented before the Applied Mathematics Advisory Council at the University of California at Los Angeles, January 16, 1953.

P-364. Analytical approximations, volume VII. C. Hastings, Jr., and J. P. Wong, Jr. 1-16-53. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, and P-358. 6 pp. See also P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.

● **P-365. A behavioral model of rational choice.** H. A. Simon. 1-20-53. Unclassified.

A description of a model which defines rational choice by organisms of limited computational ability. 16 pp. Published in *The Quarterly Journal of Economics*, February, 1955.

P-367 (out of print). Totalitarianism and the future. Paul Kecskemeti. 1-23-53. Unclassified.

A discussion of the free world versus totalitarianism with particular reference to what can be expected, in the light of past experience, (1) in the event of a conflict and (2) if there is continued coexistence. 23 pp. Published in *Totalitarianism: Proceedings of a Conference Held at the American Academy of Arts and Sciences, March, 1953*, ed. by C. J. Friedrich, Harvard University Press, Cambridge, Massachusetts, 1954. \$6.50. Presented before the American Academy of Arts and Sciences at Boston, Massachusetts, March 8, 1953.

P-368 (Part I). Attenuation of gamma rays—I: transmission value for finite slabs of lead, iron, and the Compton scatterer. G. H. Peebles. 1-23-53. Unclassified.

A discussion of several methods of gamma-ray transmission which (1) determine the total probability of transmission with any number of scatterings, (2) check the results of the calculations, and (3) augment results for the pure Compton scatterer by an application of the thin-slab method to air. 77 pp. Illus. See R-240. Published in the *Journal of Applied Physics*, October, 1953. Presented before a Shielding Information meeting at White Plains, New York, May 16, 1952.

P-368 (Part II). Attenuation of gamma rays—II: transmission values for various materials and geometries. G. H. Peebles. 3-18-53. Unclassified.

A discussion of the effect of the total absorption coefficient variation on gamma-ray-transmission probabilities. This extension to Part I leads to estimates of the build-up factors for a material of arbitrary atomic number Z . In addition, photon and energy densities arising from a plane of sources, a line of sources, and a point source in an infinite homogeneous medium, where the material of the medium is (1) iron and (2) lead, are given. 59 pp. Illus. See R-240. Published in the *Journal of Applied Physics*, December, 1953. Presented before a Shielding Information meeting at White Plains, New York, May 16, 1952.

P-370 (out of print). The Soviet purge: 1953 version. H. S. Dinerstein. 2-11-53. Unclassified.

An attempt to determine the reason for the current Soviet purges: whether it is anti-Semitism or a re-enactment of the mass purges of the ruling groups in the thirties. 25 pp.

P-372. Military demonstration and disclosure of new weapons. Bernard Brodie. 2-11-53. Unclassified.

A discussion of military demonstrations (intended primarily to convey purpose or intention or to convey capability) in relation to the disclosure of new weapons. In addition, the advantages obtained from disclosure of military technological advances against off-setting costs are summarized. 25 pp. Published in *World Politics*, April, 1953.

● **P-374. Permanent setups for IBM calculators.** William Orchard-Hays. 2-17-53. Unclassified.

A discussion of the efficiency of different methods of computation wherein the elementary functions and others must be evaluated on IBM calculators. 19 pp.

P-376. Analytical approximations, volume VIII. C. Hastings, Jr., and J. P. Wong, Jr. 3-2-53. Unclassified.

A continuation of a series of papers on analytical approximations. 6 pp. See also P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.

● **P-377. The history and development of the electronic computer project at the Institute for Advanced Study.** W. H. Ware. 3-10-53. Unclassified.

An indication of some of the early history of the electronic digital art, and a discussion of the digital computer work at Princeton. 21 pp. Illus. Presented before the Professional Group of the Institute for Radio Engineers at San Francisco, California, January 28, 1953.

● **P-378. Sense data in robots and organisms.** J. T. Culbertson. 5-1-53. Unclassified.

A paper which (1) presents a theory showing how sense data are produced by the passage of impulses through a nervous system and (2) applies the theory to visual sense data in flat perception. 41 pp. Illus.

P-379. A derivative test for finite solutions of games. I. L. Glicksberg. 3-12-53. Unclassified.

A proof that in a game over the square with continuous payoff M for which $\partial^n M / \partial y^n$ is of one sign, the minimizing (y) player has an optimal strategy using at most $n/2$ points (counting 0 and 1 as half points), and the maximizing player has an optimal strategy using at most n points. 7 pp. Published in the *Proceedings of the American Mathematical Society*, December, 1953.

- **P-380. On some variational problems occurring in the theory of dynamic programming.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 5-1-53. Unclassified.
Some results of an investigation of certain important variational problems involving the control of a physical system over a time interval. 50 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series 2, Vol. III, 1954.
- **P-381. The stability theory of differential-difference equations.** R. E. Bellman and J. M. Danskin, Jr. 3-17-53. Unclassified.
A survey of the stability theory of linear and nonlinear differential-difference equations with particular reference to the applications to automatic control problems in systems possessing time-lags. 28 pp. Published in the *Proceedings of the Symposium on Nonlinear Circuit Analysis*, sponsored by the Polytechnic Institute of Brooklyn, New York, 1953. Presented before the Brooklyn Polytechnic Institute Seminar on Circuit Analysis at Brooklyn, New York, March 17, 1953.
- P-382. Studies in functional equations occurring in decision processes.** T. E. Harris, R. E. Bellman, and H. N. Shapiro. 3-18-53. Unclassified.
A collection of three papers which discuss various functional equations arising from certain decision-making models. 62 pp.
- **P-383. Concave programming for gasoline blends.** A. S. Manne. 4-23-53. Unclassified.
A paper which shows how the solution to a concave programming system is applied to the problem of blending gasoline. 42 pp. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00. Presented before the Operations Research Society at Cleveland, Ohio, May 16, 1953.
- P-384. Conductive plastics in analog computing.** C. J. Nisson. 3-24-53. Unclassified.
A discussion of a conductive plastic potentiometer element which was found to possess the essential qualities necessary for practical and economical use in function generation for the analog computer. 8 pp. Illus. Published in *Electrical Manufacturing*, June, 1953.
- P-385. Some mathematical methods and techniques in economics.** I. N. Herstein. 3-24-53. Unclassified.
A presentation of some phases of pure mathematics that are in current use in the economic world. 27 pp. Published in the *Quarterly of Applied Mathematics*, October, 1953.
- **P-386. Suboptimization criteria and operations research.** R. N. McKean. 4-22-53. Unclassified.
An extended study of P-326, *Suboptimization in Operations Problems*. The present paper discusses criteria prerequisite to (1) suboptimizations that lead to improved operations within a given institutional framework, (2) institutional changes devised for increasing efficiency, and (3) descriptive or consumers' research useful to high-level suboptimization. 20 pp. Presented at The Johns Hopkins University at Baltimore, Maryland, April 22, 1953.
- P-387. Analytical approximations, volume IX.** C. Hastings, Jr., and J. P. Wong, Jr. 4-1-53. Unclassified.
One of a series on useful working approximations. 6 pp. See also P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.
- P-392 (out of print). Notes on linear programming—part I: the generalized simplex method for minimizing a linear form under linear inequality restraints.** G. B. Dantzig, A. Orden, and P. Wolfe. 4-5-54. Unclassified.
The first of a series of papers on the determination of optimum solutions to systems of linear inequalities. The present paper develops a theory for avoiding assumptions regarding rank of underlying matrices which has import in applications where little or nothing is known about the rank of some linear inequality system requiring solution. 17 pp. Also published as RM-1264. Published in the *Pacific Journal of Mathematics*, June, 1955.

P-395. On the stability of fluid flows with spherical symmetry. M. S. Plesset. 9-28-53. Unclassified.

A discussion of the conditions affecting the stability or instability of the interface between two immiscible incompressible fluids in radial motion. The stability conditions, derived by Taylor for the interface of two fluids in plane motion, do not apply to spherical flows without significant modifications. 9 pp. Published in the *Journal of Applied Physics*, January, 1954.

P-397. Analytical approximations, volume X. C. Hastings, Jr., and J. P. Wong, Jr. 4-16-53. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, and P-387. 6 pp. See also P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.

● **P-398 (out of print). On limit theorems for noncommutative operations—I.** R. E. Bellman. 4-20-53. Unclassified.

A paper dealing with the construction of a general theory which involves the limiting behavior of systems subjected to noncommutative effects. 18 pp. See P-485 (out of print).

● **P-399 (out of print). Complexity and reliability in electronic equipment.** R. R. Carhart. 4-30-53. Unclassified.

A study of the complexity problem as a source of unreliability in electronic equipment. In addition, the concept of critical complexity is discussed whereby equipment is assumed to have a reliability of 90 per cent. 2 pp. Presented before an Electronics Components Symposium at Pasadena, California, April 30, 1953.

● **P-401 (out of print). The new Soviet leadership.** R. L. Garthoff. 5-1-53. Unclassified. An evaluation of current developments in Soviet leadership up to May, 1953. The proceedings of the Nineteenth Party Congress in October, 1952, are examined, together with the changes in the organization and composition of the policy-making and instrumental levels of Soviet leadership. 46 pp. Tables. Also published as RM-1086.

P-402. Optimal two- and three-stage production schedules with setup times included. S. M. Johnson. 10-20-53. Unclassified.

A presentation of a simple decision rule leading to the optimal scheduling of production items minimizing the total elapsed time for the entire operation. 10 pp. See also P-456. Published in the *Naval Research Logistics Quarterly*, March, 1954. Presented before the Econometric Society at Washington, D.C., December 28, 1953.

P-403. Effects of surface tension and viscosity on Taylor instability. R. E. Bellman and R. H. Pennington. 5-15-53. Unclassified.

A discussion of a model of two fluids of infinite depth (with the interface initially in the form of a sine wave with amplitude that is small compared with wave length) to determine the effects of surface tension and viscosity. The fluids are considered incompressible, and only the linear terms in the equations of hydrodynamics are used. 26 pp. Illus. Published in the *Quarterly of Applied Mathematics*, July, 1954.

P-404. The incomplete approximator (in six fits). C. Hastings, Jr., and J. P. Wong, Jr. 6-12-53. Unclassified.

A study of the general topic of analytical approximations. 21 pp. Illus. Presented before the Digital Computers Association at Santa Monica, California, June 12, 1953.

● **P-405. On a class of games over function space and related variational problems.** W. H. Fleming. 5-20-53. Unclassified.

A study of a certain class of two-person zero-sum games in which the players have functions as pure strategies. A notion of mixed strategy is defined for such games, and a theorem is proved ensuring the existence of solutions in mixed strategies. 36 pp. Published in *Annals of Mathematics*, November, 1954.

- **P-406. The exchange between quantity and quality.** Jack Hirshleifer. 3-15-55. Unclassified.

An analysis of how general convex cost isoquants and resulting instabilities may be in the problem of quantity versus quality. This paper considers primarily the mathematical formulations of the cost function. 14 pp. Illus. Published in *The Quarterly Journal of Economics*, November, 1955.

- P-407. Bottleneck problems and dynamic programming.** R. E. Bellman. 5-22-53. Unclassified.

An attempt to indicate how the theory of dynamic programming provides a mathematical formulation and systematic approach to "bottleneck" problems of production and allocation. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September, 1953.

- P-408. Stalin as an intellectual.** N. C. Leites. 5-18-53. Unclassified.

A paper which discusses the abilities of Stalin as a theoretician. Certain dissenting moods within the technical intelligentsia during his lifetime are indicated, together with his reactions to them. 31 pp. Published in *World Politics*, October, 1953.

- P-410. Some functional equations in the theory of dynamic programming.** R. E. Bellman. 6-8-53. Unclassified.

A statement of the results without proof concerning specific functional equations of the dynamic programming theory. 9 pp. See also R-245 (out of print). Published in the *Proceedings of the National Academy of Sciences of the United States of America*, October, 1953.

- **P-412. Inequalities.** R. E. Bellman. 6-8-53. Unclassified.

An elementary presentation of some fundamental inequalities, and a discussion of an algebraic and a geometric approach to the theory of inequalities. 10 pp. Published in the *Mathematics Magazine*, September-October, 1954. Presented before the Third Annual Conference of Mathematics Teachers at the University of California at Los Angeles, July 8, 1953.

- P-414. A simple derivation of the Poisson distribution.** R. E. Kalaba. 6-11-53. Unclassified.

A straightforward derivation of the Poisson distribution, based on an idea of G. Morant. 2 pp.

- P-415. Analytical approximations, volume XI.** C. Hastings, Jr., and J. P. Wong, Jr. 7-1-53. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, and P-397. 5 pp. See also P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.

- P-416. The EIP: an external and internal program setup for IBM's Model II CPC.** H. T. McGrath, Jr., W. Orchard-Hays, and J. C. Shaw. 7-31-53. Unclassified.

A paper which discusses the EIP (external and internal program) setup. This converts IBM's Model II Card Programmed Calculator into an external and internal program, general purpose, floating decimal calculator capable of performing the basic arithmetic operations and many elementary functions. 21 pp. Illus. (Also, see supplement. 39 pp. Illus.) Presented before the Association for Computing Machinery at the Massachusetts Institute of Technology at Cambridge, Massachusetts, September 10, 1953.

- **P-417. Matrix inversion on an automatic calculator by row and column partitioning.** H. M. Wagner. 8-10-53. Unclassified.

A study of a method for inverting matrices by row and column partitioning and of the necessary programming for the C.P.C. (card-programmed computer). In addition, programming modifications are discussed for a high-speed electronic computer. 36 pp. Tables. Published in *Mathematical Tables and Other Aids to Computation*, July, 1954.

- **P-418. The Soviet image of the U.S.** M. J. Ruggles. 7-9-53. Unclassified.

A transcript of a talk which outlines briefly how the Russians view the United States. This study indicates several factors generally affecting national images and shows how these factors operate with particular force upon the Russian picture of the U.S. 11 pp. Presented before the Institute of Public Affairs at the University of Virginia, Charlottesville, Virginia, July 9, 1953.

- **P-419. Passage of stationary processes through linear and nonlinear devices.** A. J. F. Siegert. 10-29-53. Unclassified.

A survey of the mathematical methods which lead, in special cases, to expressions for the probability distribution of $\int_0^\alpha K(t)V(x(t)) dt$, where $K(t)$ and $V(x)$ are known functions and $x(t)$ is a random function of known statistical properties. 26 pp. Published in the *Institute of Radio Engineers—Transactions on Information Theory*, March, 1954. Presented before the Symposium on Statistical Methods in Communication Engineering at Berkeley, California, August 17, 1953.

- **P-420. The supply of female labor in World War II.** A. W. Marshall and J. Hirshleifer. 2-5-54. Unclassified.

A paper which (1) analyzes the influence of various determinates on the female labor force during World War II, and (2) attempts to discover whether the supply curve of female labor was backward-sloping. Auto-correlated error terms are considered in a multiple-regression model. 29 pp. Illus.

- **P-421. Purges in the Soviet Union and in the satellites.** H. S. Dinerstein. 8-3-53. Unclassified.

An examination of the different kinds of purges employed in the Soviet Union and its satellites to meet various political necessities. This analysis attempts to provide some basis for prognostication and for understanding events in the satellite countries. 19 pp. Published in *Problems of Communism*, December, 1953.

- **P-423. Computational problems in the theory of dynamic programming.** R. E. Bellman. 8-6-53. Unclassified.

A formulation, in terms of the dynamic programming approach, of a simple problem involving a sequence of decisions. The resultant functional equation is used to illustrate a number of approximation techniques, employing the particularly important concept of approximation in strategy space. 21 pp. Illus. Published in *Numerical Analysis, VI: Proceedings of Symposia in Applied Mathematics*, ed. by John H. Curtiss, McGraw-Hill Book Company, Inc., New York, 1955. \$7.00 Presented before the Symposium on Numerical Techniques at Santa Monica, California, August 26, 1953.

- **P-424. Approximations in numerical analysis: a report on a study.** C. Hastings, Jr. 8-13-53. Unclassified.

A report on a study, of a developmental nature, concerning the practical approximations of functions. 9 pp. Presented before the American Mathematical Society at Santa Monica, California, August 28, 1953.

- **P-426. Analytical approximations, volume XII.** C. Hastings, Jr., and J. P. Wong, Jr. 8-18-53. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, and P-415. 5 pp. See also P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.

- **P-429. On the distribution of certain functionals of Markoff processes.** A. J. F. Siegert and D. A. Darling. 4-20-54. Unclassified.

A derivation of integral equations which are satisfied by the characteristic functions of probability distributions of certain functionals. Partial differential equations are obtained in special cases whose principal solutions satisfy the integral equations. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, August, 1956. Presented before the Symposium on Statistical Methods in Communications Engineering at Berkeley, California, August 17-18, 1953.

- **P-430. Sociological aspects of the information process.** Paul Kecskemeti. 9-8-53. Unclassified.

A paper which shows that the distinction between evidential and nonevidential grounds for adopting beliefs is crucial to the study of sociology of knowledge. 32 pp. Presented before the Ford Foundation Center for Advanced Study at New York City, September 8-13, 1953.

- **P-433. A functional equation in the theory of dynamic programming and its generalizations.** R. E. Bellman and R. S. Lehman. 11-9-53. Unclassified.

A study of various analytical properties of a particular functional equation, together with a number of generalizations and extensions. 71 pp. Illus. See also RM-1368.

- **P-434. Computers unlimited: digital machines in tomorrow's business world.** W. H. Ware. 9-21-53. Unclassified.

A speech, presented on September 10, 1953, to the Purchasing Agents Association of Los Angeles, concerning the application of electronic digital computing techniques to business problems. 20 pp.

- **P-435. Comments on J. von Neumann's *The problem of optimal assignment in a two-person game*.** G. B. Dantzig. 7-21-52. Unclassified.

A simplification of certain arguments in J. von Neumann's paper reducing the optimal assignment problem to a two-person game. 5 pp.

- P-436. On the continuous gold-mining equation.** R. E. Bellman and R. S. Lehman. 10-1-53. Unclassified.

A discussion of several continuous analogues of some general functional equations in order to understand the structure of particular classes of solutions. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, February, 1954.

- **P-437. The determination of traffic in a road network: an economic approach.** M. Beckmann and C. B. McGuire. 10-6-53. Unclassified.

Part of a broader study on resource allocation problems in transportation. The present paper suggests a framework in which (1) the economic aspects of the problems involved in traffic engineering research are indicated, and (2) the various results may be integrated. 20 pp. Published in *Studies in the Economics of Transportation*, by M. Beckmann, C. B. McGuire, and C. B. Winsten, Yale University Press, New Haven, Connecticut, 1956. \$4.00.

- P-438. The vulnerability of the United States to enemy attack: elements of an unclassified research program in the social sciences.** Carl Kaysen. 10-4-53. Unclassified.

Research on the characteristics of the United States as a target. These characteristics are examined as they are at present, and as they might be in the future if subject to planned change. The available methods for estimating the effects of attacks in economic, political, and broad social terms are discussed, and the measures that can be taken to reduce these effects are indicated. The cost of these measures is also shown. 23 pp. Published in *World Politics*, January, 1954.

- **P-439. Note on the numerical treatment of second-order differential equations.** R. Latter and H. Kahn. 10-7-53. Unclassified.

A solution of general second-order differential equations by an implicit scheme which proceeds by converting the differential equation into an integral equation. 4 pp.

- P-440. The product form for the inverse in the simplex method.** G. B. Dantzig and W. Orchard-Hays. 10-9-53. Unclassified.

A description of a process by which a square nonsingular matrix may be expressed as a product of elementary matrices. This approach is useful in the simplex method which involves a stepwise change of basis matrix. 7 pp. Published in *Mathematical Tables and Other Aids to Computation*, April, 1954.

- P-441. Analytical approximations, volume XIII.** C. Hastings, Jr., and J. P. Wong, Jr. 10-9-53. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, and P-426. 7 pp. See also P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117.

P-1184, P-1208, P-1217, P-1229, and P-1301. Published in *Mathematical Tables and Other Aids to Computation*, January, 1954.

- **P-443. Systems research and personnel management.** R. L. Chapman. 10-23-53. Unclassified.

A paper which defines systems research and relates it to the job of the personnel manager. 17 pp. Presented before the Personnel Managers' Conference at Carlsbad, California, October 24, 1953.

- P-444. Military implications of nuclear weapon developments.** Bernard Brodie. 10-30-53. Unclassified.

An appraisal of the military importance of thermonuclear weapons. The author attempts to indicate the present or future transportability of thermonuclear weapons in existing types of aircraft, their energy yield or probable range of yields, and their cost per unit to produce, particularly in relation to the resources involved in manufacturing fission bombs. 21 pp. Published in *Foreign Affairs*, January, 1954.

- **P-447. Experiments on "The cortical correlate of pattern vision."** W. H. Emmons, R. Hennessey, and J. L. Kennedy. 11-3-53. Unclassified.

A repetition of the Kohler-Held experiment in order to investigate a DC potential change ("The Cortical Correlate of Pattern Vision"), associated with a variation in the state of the cells of the visual area of the cortex produced by the stimulus. 14 pp. Illus. Presented before the Western Psychological Association at Seattle, Washington, June 17, 1953.

- **P-448. The allocation of switching work in a system of classification yards.** M. Beckmann, T. C. Koopmans, C. B. McGuire, and C. B. Winsten. 12-3-53. Unclassified.

A paper which examines, from an economic standpoint, the switching work of a given system of classification yards through which fixed traffic flows move. 11 pp. Published in the *Proceedings of the Railway Systems and Procedures Association*, December, 1953. Presented before the Railway Systems and Procedures Association at Chicago, Illinois, November 4, 1953, and before the Econometric Society at Montreal, Quebec, Canada, September 11, 1954.

- P-449. Real wages in the Soviet Union, 1928-1952.** J. G. Chapman. 10-17-53. Unclassified.

One of several RAND studies of the important factors in the Soviet economy. The present study contains data on changes in the cost of living and in real wages for the years 1928, 1937, 1948, and 1952. 51 pp. Illus. Published in *The Review of Economics and Statistics*, May, 1954.

- P-452. Numerical solution of a spherical blast wave.** H. L. Brode. 11-10-53. Unclassified.

A paper which uses the strong shock, point source, similarity solution for an ideal gas as initial conditions in numerically integrating the differential equations of gas motion in Lagrangian form. 14 pp. Illus. Published in the *Bulletin of the American Physical Society*, April 29, 1954. Presented before the American Physical Society at Washington, D.C., April 30, 1954.

- P-454. Dynamic programming and a new formalism in the calculus of variations.** R. E. Bellman. 11-12-53. Unclassified.

A proof that the functional equation technique, used in the solution of mathematical problems arising from multistage decision processes, may be used to provide a new approach to some classical problems in the calculus of variations. 7 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, April, 1954.

- P-455. Some problems in the theory of dynamic programming.** R. E. Bellman. 11-2-53. Unclassified.

A consideration of a simple multistage investment problem as an illustration of the dynamic programming method. It is shown that the solution of the functional equation, replacing the decision problem, yields a solution of the original problem. 20 pp. Published in *Econometrica*, January, 1954.

- P-456. Some combinatorial problems arising in the theory of multistage processes. R. E. Bellman and O. A. Gross. 11-13-53. Unclassified.

A study to determine approximate solutions to numerous important multistage scheduling problems by the technique of continuous approximation. In addition, the functional equation approach of the theory of dynamic programming is used to derive an alternate proof of a result contained in P-402, *Optimal Two- and Three-stage Production Schedules with Setup Times Included*. 14 pp. Published in the *Journal of the Society for Industrial and Applied Mathematics*, September, 1954.

- P-457. On some applications of the theory of dynamic programming to logistics. R. E. Bellman. 11-19-53. Unclassified.

A discussion of some simple, but nontrivial, dynamic programming problems of interest to logisticians—to illustrate what kinds of problems are amenable to our techniques, what analytic results may be expected, and what computational problems must be utilized in general. 23 pp. Published in the *Naval Research Logistics Quarterly*, June, 1954.

- P-458. German rearmament and the old military elite. Hans Speier. 11-16-53. Unclassified.

A commentary on the strategic issues relating to German rearmament based on an analysis of the views of former German military elite, as social representatives of German military tradition and as persons potentially competent to discuss the military implications of the European Defense Community. 30 pp. Published in *World Politics*, January, 1954.

- △ ● P-461 (out of print). Interrelations between linear programming and game theory. P. A. Samuelson. 11-24-53. Unclassified.

Computations showing how every two-person zero-sum game problem may be converted into a related linear programming problem and how the latter may be converted into the former. 31 pp.

- P-462. Some economic aspects of fissionable material. Stephen Enke. 11-25-53. Unclassified.

A theoretical discussion of an optimum program for the production, allocation, and use of fissionable material according to economic precepts—once important political and military decisions have been made. In particular, U^{235} and Pu^{239} , which involve numerous economic suboptimizations, are discussed. 16 pp. Illus. Published in *The Quarterly Journal of Economics*, May, 1954.

- P-463. On perturbation methods involving expansions in terms of a parameter. R. E. Bellman. 11-25-53. Unclassified.

A proof that the effectiveness of the method of expanding the solution in terms of a parameter may be greatly increased in many cases by expanding in terms of a suitably chosen function of the parameter. 10 pp. Published in the *Quarterly of Applied Mathematics*, July, 1955.

- P-465. On the Crank-Nicolson procedure for solving parabolic partial differential equations. M. L. Juncosa and D. M. Young. 9-13-54. Unclassified.

A presentation of convergence proofs of the Crank-Nicolson procedure for the case of $u_t = u_{xx}$ with homogeneous boundary conditions and fairly general conditions on the initial function $f(x)$. 28 pp. Presented before the American Mathematical Society at Baltimore, Maryland, December 29, 1953.

- P-466. The effect of reliability of "supervisory" equipment on the accuracy of a "supervised" system. A. W. Boldyreff. 5-28-54. Unclassified.

A study dealing with a basic system—the performance of which degenerates through random errors increasing with the square root of operating time—that is, periodically corrected by a system of supervisory equipment. 6 pp. Illus. Published in the *Journal of the Operations Research Society of America*, August, 1954. Presented before the Operations Research Society of America at Boston, Massachusetts, November 23, 1953.

- P-467. Impulsive loading on an elastic half-plane. J. D. Cole and J. H. Huth. 12-14-53. Unclassified.

A study which considers the wave system resulting from a step loading on an elastic half-plane. 6 pp. Illus. Published in the *Journal of Applied Mechanics*, September, 1954.

- **P-468. Notes on parametric linear programming.** A. S. Manne. 12-15-53. Unclassified.
A discussion of the case of a linear programming problem in which the payoff vector depends linearly upon a scalar. 7 pp. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00. Presented before the Econometric Society at Washington, D.C., December 28, 1953.

- **P-469. Notes on matrix theory—IV (an inequality due to Bergström).** R. E. Bellman. 12-21-53. Unclassified.

A presentation of two proofs of an inequality concerning positive definite matrices. 3 pp. Published in *The American Mathematical Monthly*, March, 1955.

- P-470. **Notes on the optimal choice of weapons.** J. Marschak and M. R. Mickey, Jr. 11-30-51. Unclassified.

A study which determines a weapon system that, subject to a given cost constraint, will maximize the mathematical expectation of the military utility (defined as the function of damage to the enemy, or the probability of victory). 36 pp. Illus. Published in the *Minutes of the Third Annual Logistics Conference*, March, 1952. Presented before the Third Annual Logistics Conference (jointly sponsored by the George Washington University and the Office of Naval Research) at Washington, D.C., January 3, 1952.

- P-471. **War and peace.** Hans Speier. 12-29-53. Unclassified.

A review of the history of civilized versus total war in an attempt to justify the viewpoint of the author that it is easier to restrict war than to establish peace. 15 pp. Published in *Man's Right to Knowledge: Second Series (Present Knowledge and New Directions)*, Herbert Muschel, New York, 1954, and in the *Bulletin of the Atomic Scientists*, November, 1955. Presented over the Columbia Broadcasting System for the Columbia University Bicentennial on November 21, 1954.

- **P-473. On a new iterative algorithm for finding the solutions of games and linear programming problems.** R. E. Bellman. 6-1-53. Unclassified.

A discussion of an iterative procedure which yields the value of a game very rapidly. 15 pp. Tables.

- **P-474-AEC. Thermodynamics of the Thomas-Fermi atom at low temperatures.** J. J. Gilvarry. 1-15-54. Unclassified.

A study of the results derived on the atom model by Brachman in order to examine the thermodynamics of the Thomas-Fermi method for the case of a first-order temperature perturbation. 36 pp. Illus. See supplement P-520. Published in *The Physical Review*, November 15, 1954.

- P-475. **Equilibrium analysis: the stability theory of Poincaré-Liapounoff and extensions.** R. E. Bellman. 1-13-54. Unclassified.

An appendix to a chapter in *Modern Mathematics for the Engineer*, ed. by E. F. Beckenbach, McGraw-Hill Book Company, Inc., New York, 1956. \$7.50. This paper attempts to sketch briefly several important aspects of the stability theory of equilibrium states. 10 pp.

- P-479. **A motor gasoline blending problem.** A. S. Manne. 1-25-54. Unclassified.

A description of a joint attempt of the Union Oil Company and RAND to study a gasoline blending problem. This paper applies mathematical economics to an actual industrial situation in order to coordinate manufacturing operations more effectively with other branches of the corporation. 2 pp. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00. Presented before the Western Computer Conference of Los Angeles, California, February 12, 1954.

- △● **P-480 (out of print). On a functional equation arising in the problem of optimal inventory.** R. E. Bellman. 1-28-54. Unclassified.

A study of a particular functional equation arising in the mathematical treatment of economic processes involving uncertain demand. 12 pp.

- P-481. **Petroleum refinery operations scheduling—chapter II: conventional methods of refinery economic analysis.** A. S. Manne. 5-1-54. Unclassified.

A discussion of such conventional methods of economically analyzing petroleum refineries as standard cost accounting formulae, gasoline replacement value estimates, and multiple alternative

comparisons. 12 pp. Illus. See also P-484, P-487, P-489, P-493, P-502, and P-503. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

- **P-482. Computational experience in solving linear programming problems.** William Orchard-Hays. 3-15-54. Unclassified.

An attempt to indicate the usefulness of computing machines for solving linear programming problems by the simplex method. 19 pp. Illus. Published in the *Proceedings of the Symposium on Operations Research in Business and Industry*, April 8-9, 1954. Presented before the Operations Research Symposium at Kansas City, Missouri, April 8, 1954.

- P-483. Bottleneck problems, functional equations, and dynamic programming.** R. E. Bellman. 1-29-54. Unclassified.

A presentation of a technique used to treat some of the novel types of mathematical problems which arise from studies of interindustry processes. 23 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September, 1953.

- P-484. Petroleum refinery operations scheduling—chapter III: a crude oil allocation problem.** A. S. Manne. 5-1-54. Unclassified.

A discussion of the complex scheduling problem of assigning crude oils between the various refineries of a multiplant firm. 35 pp. Tables. See also P-481, P-487, P-489, P-493, P-502, and P-503. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

- △ ● **P-485 (out of print). On limit theorems for noncommutative operations—II: a generalization of a result of Koenig.** R. E. Bellman. 2-9-54. Unclassified.

A generalization of a classical theorem of Koenig, dealing with iteration and the solution of a functional equation. 10 pp. See P-398 (out of print).

- **P-486. A general survey of the theory of dynamic programming.** R. E. Bellman. 2-11-54. Unclassified.

A discussion of (1) some mathematical problems arising in connection with multistage decision problems and (2) various mathematical techniques to treat these problems. 59 pp. Published as Chapter II in *Modern Mathematics for the Engineer*, ed. by E. F. Beckenbach, McGraw-Hill Book Company, Inc., New York, 1956. \$7.50.

- P-487. Petroleum refinery operations scheduling—chapter V: a gasoline blending problem.** A. S. Manne. 5-1-54. Unclassified.

An extension of Chapter IV (P-489) concerning the operation of a typical kind of conversion unit. The present study examines another intrarefinery economic balance problem—the selection of an optimal gasoline blending schedule. 58 pp. Tables. See also P-481, P-484, P-493, P-502, and P-503. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

- P-488. W.K.B. approximation through the turning point.** A. A. Broyles. 2-15-54. Unclassified.

An analysis of the W.K.B. (Wintzel-Kramers-Brillouin) approximation for hydrogen bound wave functions through the classical turning point. 11 pp. Illus. Published in *The Physical Review*, July 15, 1954. Presented before the American Physical Society at Washington, D.C., April 29-May 1, 1954.

- P-489. Petroleum refinery operations scheduling—chapter IV: a naphtha reforming problem.** A. S. Manne. 5-1-54. Unclassified.

An examination of the problem of selecting the operating conditions and the scale of the reforming equipment—in order to maximize the refinery realization that can be obtained from a given volume of a straight-run naphtha. 33 pp. Illus. See also P-481, P-484, P-487, P-493, P-502, and P-503. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

P-490. Some applications of the theory of dynamic programming. R. E. Bellman. 5-14-54. Unclassified.

A description of the theory of dynamic programming. To illustrate the general principles, two particular problems—one of deterministic type and one of stochastic type—are treated. 18 pp. Published in the *Journal of the Operations Research Society of America*, August, 1954.

• **P-491. The theory of dynamic programming as applied to a smoothing problem.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 2-16-54. Unclassified.

A consideration of a problem involved in adjusting production facilities to a fluctuating demand, using the method of continuous approximation to a discrete process. 10 pp. Published in the *Journal of the Society for Industrial and Applied Mathematics*, June, 1954.

• **P-492 (out of print). Studies on bottleneck problems in production processes.** R. E. Bellman and R. S. Lehman. 2-25-54. Unclassified.

A discussion of some representative problems occurring in the study of interindustry processes. Part I considers a simple mathematical model of two interacting interdependent industries engaged in the production of one item. Part II converts a problem, involving the maximization of an integral subject to integral constraints, into one of solving a functional equation which may be converted into a nonlinear partial differential equation. 52 pp. Illus. See also RM-1125 (out of print).

P-493. Petroleum refinery operations scheduling—chapter VI: cracking, recycling, and blending—an integrated refinery problem. A. S. Manne. 5-1-54. Unclassified.

An analysis of the operations of a hypothetical thermal cracking refinery. 78 pp. Illus. See also P-481, P-484, P-487, P-489, P-502, and P-503. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

Δ • **P-495 (out of print). Dynamic programming and the calculus of variations—I.** R. E. Bellman. 3-5-54. Unclassified.

A demonstration that the theory of dynamic programming can be applied to yield a nonlinear partial differential equation for eigenvalue problems. 17 pp.

P-497. Atomic weapons and ground combat: search for organization and doctrine. H. A. De Weerd. 3-12-54. Unclassified.

A discourse on the organizational requirements and doctrines of ground force operations in the day of atomic plenty. 13 pp. Published in the *United States Army Combat Forces Journal*, July, 1954.

• **P-498. A method for determining the effects of elevated temperature on structural design and weight.** W. R. Micks. March 1954. Unclassified.

A method (including temperature and time effects) to determine allowable stresses for structures operating at elevated temperatures. Creep-buckling and permanent structural deformation are considered as well as the static or short-time properties of the material at elevated temperatures. 53 pp. Illus. Presented before the Society of Aeronautical Weight Engineers at Baltimore, Maryland, May 10-13, 1954.

P-499. On the convergence of a procedure of DuFort and Frankel for the numerical solution of parabolic partial differential equations. M. L. Juncosa. 2-1-54. Unclassified.

A proof of convergence of the solution of a partial difference equation to the solution of the classical problem of limits for one-dimensional diffusion with zero boundary conditions. 17 pp.

P-500. A note on the relativistic Thomas-Fermi atom model. J. J. Gilvarry. 4-1-54. Unclassified.

A demonstration that an expression for the density of states, derived from the Dirac wave equation for a central field, removes the convergence difficulties in the usual relativistic Thomas-Fermi equation. 4 pp. Published in *The Physical Review*, July 1, 1954.

P-501. German geopolitics revived. E. W. Schnitzer. 3-21-54. Unclassified.

A condensation of a longer treatise (RM-1210), *German Geopolitics Revived: A Survey of Geopolitical Writing in Germany Today*. 22 pp. Published in *The Journal of Politics*, August, 1955.

P-502. Petroleum refinery operations scheduling—chapter I: introduction. A. S. Manne. 5-1-54. Unclassified.

An investigation of several examples of the actual use of mathematical economics in representative oil refinery scheduling problems. The appendix contains a glossary of technical terms. 8 pp. See also P-481, P-484, P-487, P-489, P-493, and P-503. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

P-503. Petroleum refinery operations scheduling—chapter VII: the economist and the operations scheduler. A. S. Manne. 5-1-54. Unclassified.

A discussion of various contributions the econometrician makes to the refinery programming problem and what he can learn about the refinery operator. 3 pp. See also P-481, P-484, P-487, P-489, P-493, and P-502. Published in *Scheduling of Petroleum Refinery Operations*, Harvard Economic Studies, No. 98, Harvard University Press, Cambridge, Massachusetts, 1956. \$5.00.

P-505. A note concerning the organization of an IBM type 701 installation. J. D. Madden. 4-7-54. Unclassified.

An examination of several projects, under way in the RAND Numerical Analysis Department, concerning (1) the organizational setups used at various IBM Type 701 installations, (2) the demonstration of a test to determine good computing job prospects from bad ones, and (3) the installation of a Polaroid Land Camera in the 701 room to expedite checking of machine programs. 13 pp. Published in IBM's *Proceedings of Computation Seminar—Type 701*, May 3-6, 1954. Presented before the IBM Computation Seminar at Endicott, New York, May 5, 1954.

P-507. The metamorphosis of the Stalin myth. R. C. Tucker. 4-16-54. Unclassified.

An attempt to interpret the new "Stalin myth" and the emerging "cult of the Party" in Russia. Certain aspects of the post-Stalin train of events are investigated, and various trends and issues in the internal political life of the USSR since the death of Stalin are noted. 40 pp. Published in *World Politics*, October, 1954.

P-509. Applications of a cathode ray tube readout device for the IBM 701 electronic data processing machine. Paul Armer. 4-8-54. Unclassified.

A description (from the viewpoint of the user) of a Cathode Ray Tube Readout Device for the IBM 701 electronic data processing machine. This device is applied to a particular problem, which involves large output and is the inverse of the data reduction problem. In addition, the general uses of the CRT unit are examined. 11 pp. Published in IBM's *Proceedings of Computation Seminar—Type 701*, May 3-6, 1954. Presented before the IBM Computation Seminar at Endicott, New York, May 5, 1954.

P-510. Solution of a large-scale traveling-salesman problem. G. B. Dantzig, D. R. Fulkerson, and S. M. Johnson. 7-8-54. Unclassified.

A solution for the shortest route of a salesman (1) starting from a given city, (2) visiting each of a specified group of cities, and (3) returning to the original point of departure. 35 pp. Illus. See companion piece P-1281. Published in the *Journal of the Operations Research Society of America*, November, 1954. Presented before the Econometric Society at Pasadena, California, June, 1954, and at Montreal, Quebec, Canada, September, 1954.

P-511. Allocation of indirect costs. G. H. Fisher. 9-19-56. Unclassified.

An attempt to solve the cost distribution problem arising when the operating costs of interdependent indirect (support) activities are to be allocated to end product (direct) activities. 16 pp. Illus.

P-513. Monotone convergence in dynamic programming and the calculus of variations. R. E. Bellman. 9-3-54. Unclassified.

A proof that the method of approximation in policy space, developed in dynamic programming theory, yields monotone convergence in the calculus of variations. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, November, 1954.

P-515. Analytical approximations, volume XIV. C. Hastings, Jr., and J. P. Wong, Jr. 4-22-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, and P-441. 6 pp. See also P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

P-517. Compensation for war damage: an economic view. Jack Hirshleifer. 4-29-54. Unclassified.

A study of the effects of possible insurance or indemnity schemes which might be adopted on the resource allocation of the nation both before and after bombing. This paper indicates that (1) a properly conceived insurance plan will encourage private actions in peacetime to reduce our national vulnerability to bombing and (2) conversely, a poorly conceived plan will tend to discourage expenditures designed to reduce vulnerability. 26 pp. See also P-519. Published in the *Columbia Law Review*, February, 1955.

P-519. War damage insurance. Jack Hirshleifer. May 1953. Unclassified.

A study recommending that war damage insurance be offered to protect property-owners from losses attributed to enemy action. Such a measure is shown to encourage private actions which will, aside from governmental measures, tend to reduce the physical and economic vulnerability of our cities and industry to enemy bombing. 21 pp. See also P-517. Published in *The Review of Economics and Statistics*, May, 1953.

P-520-AEC. Solution of the temperature-perturbed Thomas-Fermi equation. J. J. Gilvarry. 4-22-54. Unclassified.

A supplement to P-474-AEC, *Thermodynamics of the Thomas-Fermi Atom at Low Temperatures*. The present paper solves analytically the temperature-perturbed Thomas-Fermi equation of the n th order in terms of quadratures on the unperturbed solution corresponding to zero temperature. 17 pp. Illus. Published in *The Physical Review*, November 15, 1954.

P-521. Significant features of Soviet military doctrine. R. L. Garthoff. 5-11-54. Unclassified.

A condensation of a book, *Soviet Military Doctrine*, published by The Free Press. 25 pp. See R-223 (out of print).

P-522. U.S. reaction to North Korean aggression. A. L. George. 5-17-54. Unclassified.

An attempt (1) to reconstruct, from contemporary newspaper accounts and the MacArthur hearings, how U.S. policymakers interpreted the North Korean aggression in mid-1950 and (2) to show how the U.S. reaction to the aggression was influenced by uncertainty as to broader Soviet intentions. 47 pp. Published in *World Politics*, January, 1955.

• **P-523. A review of Fourier analysis and autocorrelation.** L. E. Larmore. 5-6-54. Unclassified.

A review of the fundamental concepts of Fourier analysis, correlation, and autocorrelation. The examples cited illustrate concepts applicable to various problems. 30 pp. Illus. Presented before the Guided Missile Infrared Conference at Santa Monica, California, March 12, 1954.

P-524. Possible U.S. military strategies. Bernard Brodie. 10-11-54. Unclassified.

A discourse on possible U.S. military strategies allowing the widest latitude of choice to our diplomacy. The operations discussed are (1) preventive war, (2) the blunting of enemy strategic air attacks, and (3) deterrence. 20 pp. Published in *The Reporter*, November 18, 1954. Presented before the Army War College, Carlisle Barracks, Pennsylvania, March 30, 1954.

• **P-526. Nonmilitary applications of operations research.** A. I. Kent. 5-14-54. Unclassified.

A discussion of (1) several fields contributing to Operations Research and (2) its prospects. This term is defined as that part of applied science concerned with analyzing the operations of an organization in order to obtain information for the executive making decisions on organization policy. 20 pp. Presented before the Valley Junior College at Van Nuys, California, June 2, 1954.

P-527. Some notes on the evolution of air doctrine. Bernard Brodie. 12-1-54. Unclassified.

Two lectures presented at the Air War College, Maxwell Air Force Base, Alabama, on November 9, 1953. The influence of Douhet on present Air Force thinking, together with his various contributions to the principles of war, are noted. In addition, the experience of World War II is reviewed in relation to strategic bombing and his doctrines. 31 pp. Incorporated in R-335. Published in *World Politics*, April, 1955. Incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, N.J., 1959. \$6.50.

P-528-RC. Political views of the German civil service. J. H. Herz. 6-2-54. Unclassified.

A study, based on interviews in 1953, of prevailing political attitudes on foreign policy among members of the German civil service. 123 pp. Published in *World Politics*, October, 1954. Also published as Chapter 4, *West German Leadership and Foreign Policy*, Row, Peterson & Co., Evanston, Illinois, 1957. \$7.00.

- **P-529. Observations on the growth of information-processing centers.** M. G. Weiner. 5-21-54. Unclassified.

Data on the process by which an individual group may become an effective organization. A model of organizational development is considered, together with various mechanisms used for handling complex task situations and for controlling and stimulating organizational development. 31 pp. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

P-530. Which program do we mean in "program budgeting"? David Novick. 5-12-54. Unclassified.

A discourse on the meaning and background development of the word "program." The author attempts to justify this definition and discusses it in relation to "program budgeting." 22 pp. Published in the Armed Forces Management Association *Newsletter*, August-September, 1954. Presented before the Department of Defense Management Technicians Association at Washington, D.C., May 12, 1954.

- **P-531. The use of multistage sampling schemes in Monte Carlo computations.** A. W. Marshall. 6-3-54. Unclassified.

A review of importance sampling, a technique whereby Monte Carlo computations are made more efficient—provided the probability distribution, from which the sample observations are drawn, is judiciously chosen. 20 pp. Illus. Published in *Symposium on Monte Carlo Methods*, ed. by H. A. Meyer, John Wiley & Sons, Inc., New York, 1956. \$7.50. Presented at the Symposium on Monte Carlo Methods at Gainesville, Florida, March 17, 1954.

P-532. Relationship between the masses and magnitudes of small meteoroids. H. K. Kallmann. 6-8-54. Unclassified.

An attempt to evaluate meteor masses as a function of their visual magnitudes by examining the duration of visibility and the variation of the luminous efficiency with velocity in various magnitude ranges. 33 pp. Illus. Published in *Meteor Physics*, ed. by B. Lovell, Pergamon Press, Ltd., London, England, 1955. \$8.50.

- **P-533. Air cargo transport scheduling: an illustrative block triangular system.** A. S. Manne. 6-11-54. Unclassified.

A discussion of a block triangular and purely static model of air transport operations in an attempt to reduce the costs of computing and to increase the size of the systems considered. 7 pp. Table. Presented before the Econometric Society at Pasadena, California, June 18, 1954.

P-534. A critical review of the "learn-while-you-sleep" studies. C. W. Simon and W. H. Emmons. 10-14-54. Unclassified.

An analysis of the experimental design, statistics, methodology, and criteria of ten sleep-learning studies. This paper describes attempts to determine whether one can learn during sleep as well as (from the standpoint of economy of time and effort) comparative data on waking and resting learning. 35 pp. Published in the *Psychological Bulletin*, July, 1955.

P-537. Systems engineering. A. W. Boldyreff. 6-16-54. Unclassified.

A discussion of Systems Engineering—a technique whereby the maximum operational effect, extracted from the available or potentially available resources in material and personnel, is determined. 13 pp. Published in the *Journal of the Joint Western Region American Society for Quality Control—Aircraft Technical Committee*, August, 1954. Presented before the Joint Western Region American Society for Quality Control—Aircraft Technical Committee Conference at San Diego, California, August 9–10, 1954.

P-541. A note on plastic torsion. J. H. Huth. 10-26-54. Unclassified.

A numerical treatment of the torsion of a square rod using a nonlinear stress-strain relationship. The feasibility and expected accuracies of this method are discussed. 13 pp. Illus. Published in the *Journal of Applied Mechanics*, September, 1955.

P-542. Quantitative estimate of frequency and mass distribution of dust particles causing the zodiacal light effect. H. K. Kallmann. 8-31-54. Unclassified.

An estimate (based on visual and radar observations) of the meteors and meteoric dust entering the earth's atmosphere per day. From the number distribution as a function of radii for the zodiacal light effect, meteoric and zodiacal dust are compared for particles having radii of .025–.0001 centimeters. 20 pp. Illus. Published in *Les Particules Solides dans les Astres*, University of Liège Press, Belgium, 1955. Presented at the Sixth International Astrophysical Symposium at Liège, Belgium, July 15–17, 1954.

• **P-544. Asymptotic solutions for a class of integral equations.** Richard Latter. 7-9-54. Unclassified.

A method of treatment which determines asymptotic solutions as well as approximate eigenvalues for a certain integral equation. 19 pp. Published in the *Quarterly of Applied Mathematics*, April, 1958.

• **P-545. Methodology for reliable failure reporting from maintenance personnel.** F. A. Hadden and L. W. Sepmeyer. 7-15-54. Unclassified.

A study, undertaken in mid-1952 at McChord Air Force Base, to determine how the maintenance man is made a reliable link in the failure reporting process. In addition, several basic principles contributing to a successful reporting system are discussed. 9 pp. Published in the *Institute of Radio Engineers—Transactions on Engineering Management*, January, 1956.

P-546-RC. Cold water on salt water. W. W. Taylor. 7-16-54. Unclassified.

A summary of a survey on the technology and economics of water supply which delineates the problems of water supply and indicates the more important areas of research in this field. 22 pp.

• **P-547. The nature and applications of process analysis.** H. M. Markowitz. 5-24-54. Unclassified.

A study to determine what combinations of civilian and military outputs may be produced with specified national resources. The author discusses (1) the detail entering a process analysis model, (2) the questions answered by such a model, and (3) various considerations involved in the building, testing, and using of a process analysis model of the economy as a whole. 23 pp. Tables. Presented before the International Seminar on Input-Output Relations at Pisa, Italy, July 5, 1954.

P-548. Is dispersal good defense? G. Cooper and R. N. McKean. 9-15-54. Unclassified.

A companion study to P-301 of the same title. 16 pp. Published in *Fortune*, November, 1954.

P-550. The theory of dynamic programming. R. E. Bellman. 7-30-54. Unclassified.

An examination of various mathematical features of the dynamic programming theory. Its fundamental concepts are reviewed, and some representative problems are discussed. 23 pp. Published in the *Bulletin of the American Mathematical Society*, November, 1954. Presented before the American Mathematical Society at Laramie, Wyoming, September 2, 1954.

P-551. Employment and unemployment in the USSR. Warren Eason. 3-14-55. Unclassified.

An evaluation of (1) the results of the Soviet 1926 labor force census, (2) the principal changes occurring through 1939, (3) several measures of the total labor force during the late thirties, and

(4) possible indications of unemployment. 59 pp. Tables. Published as *Policies To Combat Depression*, Universities-National Bureau Committee for Economic Research, Princeton University Press, Princeton, New Jersey, 1956. \$8.50. Presented before the Universities-National Bureau Committee Conference at Princeton University, Princeton, New Jersey, September 17-18, 1954.

- **P-552. On the "bang-bang" control problem.** R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 3-2-55. Unclassified.

The solution of a least time differential control problem. A particular example is presented in detail. 16 pp. Illus. Published in the *Quarterly of Applied Mathematics*, April, 1956.

- **P-554. Diagram of the structure of the upper atmosphere.** W. W. Kellogg. 8-1-54. Unclassified.

An attempt to describe some of the physical features of the upper atmosphere. The ordinate is height, and the distribution of several parameters is plotted, accompanied by the levels at which various chemical and physical processes occur. This diagram was used as a slide, for presentation before the Institute of Aeronautical Sciences at Los Angeles, California, March 8, 1955. 2 pp. Illus. Published in *American Institute of Physics Handbook*, ed. by Dwight E. Gray, McGraw-Hill Book Company, Inc., New York, 1957. \$15.00.

- P-555. Analytical approximations, volume XV.** C. Hastings, Jr., and J. P. Wong, Jr. 8-12-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, and P-515. 5 pp. See also P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

- P-556. Univariate two-population distribution-free discrimination.** D. S. Stoller. 11-15-54. Unclassified.

An examination of an asymptotically optimum distribution-free procedure for classifying a univariate random variable into one of two subpopulations. 11 pp. Published in the *Journal of the American Statistical Association*, December, 1954. Presented before the Institute of Mathematical Statistics at Montreal, Quebec, Canada, September 9-12, 1954.

- **P-557. A rational game on the square.** O. A. Gross. 8-10-54. Unclassified.

An example of a two-person zero-sum game on a closed unit square having as payoff a continuous rational function with rational coefficients. It is shown that the only optimal strategy available to either player is the Cantor function. 6 pp. Published in the *Annals of Mathematics Studies*, No. 39, 1958.

- P-559. Analytical approximations, volume XVI.** C. Hastings, Jr., and J. P. Wong, Jr. 8-25-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, and P-555. 6 pp. See also P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

- P-560. Soviet heavy industry: a dollar index of output, 1927/28-1937.** Alexander Gerschenkron. 8-30-54. Unclassified.

An attempt to measure the growth of output in Soviet heavy industry. In particular, this investigation considers the machine building, iron and steel, petroleum, coal, and electric power industries. 26 pp. Tables. Published in *The Review of Economics and Statistics*, May, 1955.

- P-561. The problem of routing aircraft: a mathematical solution.** A. R. Ferguson and G. B. Dantzig. 9-1-54. Unclassified.

An application of linear programming to a transportation problem in which a method is presented for assigning a given fleet of various aircraft types to carry an anticipated traffic load over several routes at minimum cost. 18 pp. Tables. Also published as RM-1369. Published in the *Aeronautical Engineering Review*, April, 1955.

- **P-562. Revisions and extensions to the simplex method (with side lights on programming techniques).** William Orchard-Hays. 9-2-54. Unclassified.

A suggestion that a breakdown of comprehensive operations into a set of pseudo-operations has important implications for flexibility and adaptability in a computer code. 22 pp. Published in *Econometrica*, July, 1955. Presented before the Econometric Society at Montreal, Quebec, Canada, September 13, 1954.

- P-563. A linear programming model of the U.S. petroleum refining industry.** A. S. Manne. 5-16-56. Unclassified.

An attempt to estimate for the petroleum refining industry (1) the maximum amount attainable of a certain product-mix, exclusive of jet fuel, and (2) the effect of increased production of this fuel on the output rate. Although these calculations are based upon the refining equipment and raw materials available within the U.S. on January 1, 1953, no extensive changes would be required in order to apply the model to other problems involving the petroleum technology of the 1950's. 53 pp. Illus. Also published as RM-1757. Published in *Econometrica*, January, 1958. Presented before the Econometric Society at Montreal, Quebec, Canada, September 10-13, 1954.

- **P-564. Constructive proof of the min-max theorem.** G. B. Dantzig. 9-8-54. Unclassified.

An algebraic proof of the fundamental game theorem that is elementary and constructive. An example illustrates the method. 17 pp. Also published as RM-1267-1. Published in the *Pacific Journal of Mathematics*, Spring, 1956.

- **P-565. Considerations for research in a sleep-learning program.** C. W. Simon and W. H. Emmons. 9-13-54. Unclassified.

A summary of some experimental evidence concerning sleep-training problems. This investigation discusses (1) the extent of sleep-learning studies and their evaluation and (2) psycho-physiological considerations for sleep-learning. In addition, the RAND sleep-learning laboratory is described. 74 pp. Illus.

- **P-566. Some functional equations in the theory of dynamic programming—I: functions of points and point transformations.** R. E. Bellman. 9-15-54. Unclassified.

A study of various analytic properties of a certain functional equation, arising in dynamic programming theory. In addition, existence and uniqueness theorems and convergence of successive approximations are determined. 36 pp. Published in the *Transactions of the American Mathematical Society*, September, 1955.

- P-568. Decisionmaking in the face of uncertainty—I: uncertain outcome.** R. E. Bellman. 9-21-54. Unclassified.

A discussion of numerous simple multistage decision processes where the intuitive concept of maximizing expected gain over expected cost is valid. 7 pp. See Part II, P-593. Published in the *Naval Research Logistics Quarterly*, September, 1954.

- P-569. Notes on linear programming—part XV: minimizing the number of carriers to meet a fixed schedule.** G. B. Dantzig and D. R. Fulkerson. 8-24-54. Unclassified.

A proof that the problem of determining the minimum number of carriers required to meet a fixed schedule of transportation can be made into a linear programming problem. 12 pp. Illus. Also published as RM-1328. Published in the *Naval Research Logistics Quarterly*, September, 1954.

- P-570. A review of Sven Rydenfelt's *Communism in Sweden*.** W. P. Davison. 10-8-54. Unclassified.

A review of *Communism in Sweden*, which analyzes Swedish reaction to communism in parliamentary elections. The relationship is shown between religion and voting behavior, economic conditions and the communist vote, and the role of the noncommunist Left in undercutting the Swedish Communist Party. 39 pp. Tables. Published in *The Public Opinion Quarterly*, Winter, 1954-55.

P-571-AEC. Numerical solutions of spherical blast waves. H. L. Brode. 9-29-54. Unclassified.

An attempt to solve the problem of a spherical blast in air by employing an artificial viscosity as a mechanism for avoiding shock-front discontinuities. This study considers overpressure, density, particle velocity, and position as functions of time and space. In addition, dynamic pressure, static overpressure, durations of pressure and velocity, and shock values of all quantities are described for various times and radial distances. 35 pp. Illus. Published in the *Journal of Applied Physics*, June, 1955.

P-572. On the optimal inventory equation. R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 9-28-54. Unclassified.

A summary of results connected with the optimal inventory problem. Solutions are given for the case of (1) proportional costs and arbitrary demand and (2) linear costs with constant terms representing administrative costs. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, April, 1955.

- **P-573. Techniques in putting failure data to work for management.** F. A. Hadden and L. W. Sepmeyer. 9-30-54. Unclassified.

A study of the results of RM-958-1, *A Field Trial of an Air Force Electronic Equipment Reliability Study Program*, which describes methods of failure reporting and of machine reduction, analysis, and presentation of failure data. This paper shows how a field failure reporting system can be used as a tool for controlling equipment reliability. 17 pp. Illus. See also RM-1257. Published in the *Proceedings of the First National Symposium on Quality Control and Reliability in Electronics*, November, 1954. Presented before the Quality Control and Reliability Symposium at New York City, November 12-13, 1954.

P-574. Dynamic programming and a new formalism in the theory of integral equations. R. E. Bellman. 10-1-54. Unclassified.

A proof that the functional equation technique of the dynamic programming theory may derive functional differential equations for the characteristic values of a certain integral equation, similar to those obtained for differential equation eigenvalues. 7 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, January, 1955.

- **P-575. On a quasi-linear equation.** R. E. Bellman. 10-1-54. Unclassified.

A derivation of some limit theorems for the solutions of certain nonlinear equations. Recurrence relations of this kind occur in various dynamic programming problems. 9 pp. Published in the *Canadian Journal of Mathematics*, Vol. 8, 1956.

P-576. Upper bounds, secondary constraints, and block triangularity in linear programming. G. B. Dantzig. 10-4-54. Unclassified.

An attempt to develop short-cut computational methods for solving systems whose matrices may be described as block triangular. 22 pp. Also published as RM-1367. Published in *Econometrica*, April, 1955.

P-577. On an iterative procedure for obtaining the Perron root of a positive matrix. R. E. Bellman. 10-5-54. Unclassified.

An iterative procedure—for obtaining the characteristic root of largest absolute value of a positive matrix—which yields geometric convergence. 11 pp. Published in the *Proceedings of the American Mathematical Society*, October, 1955.

- **P-578. Machine testing for deviation of data from a Poisson distribution.** F. A. Hadden. 11-8-54. Unclassified.

An outline of a practical machine method—which separates abnormal events, occurring at random, from normal events—for data that are Poisson distributed. 6 pp. Illus. Published in *Communication and Electronics*, May, 1955. Presented before the American Institute of Electrical Engineers at New York City, February 3, 1955.

P-579. Gaming as a technique of analysis. A. M. Mood and R. D. Specht. 10-19-54. Unclassified.

A discussion of gaming as an activity in which a set of rules is established to represent the context of the problem considered. 14 pp. See also P-899. Published in the *Student Publications of the School of Design, North Carolina State College*, Vol. 5, No. 3, 1956. Presented before the Operations Research Society at Washington, D.C., November 18–20, 1954.

P-580. On the optimal inventory equation. R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 7-28-55. Unclassified.

A study of numerous different multistage processes, connected with the problem of optimal inventory and stock control, which include the original process of Arrow, Harris, and Marschak. In particular, the successive approximation method is applied. 40 pp. Published in *Management Science*, October, 1955.

- **P-581. A note on infrared stellar magnitudes.** L. E. Larmore. 10-13-54. Unclassified. Computations on the luminous efficiencies of the eye and a lead sulphide detector in order to determine the blackbody radiation over temperature ranges from 300°K to $25,000^{\circ}\text{K}$. The infrared color index of stars from type M to B of the spectral series is obtained from the ratio of these efficiencies. 10 pp. Illus. Presented before the Optical Society of America at Los Angeles, California, October 14, 1954.

P-582. The blast from a sphere of high-pressure gas. H. L. Brode. 1-27-55. Unclassified.

An attempt to describe the gas dynamics resulting from the release of an isothermal sphere of gas (initially at rest and at high pressure), by numerically solving the differential equations which represent an ideal gas in radial motion. 19 pp. Published in the *Journal of Applied Physics*, June, 1955. Presented before the American Physical Society at New York City, January 27, 1955.

P-585-AEC. Atomic energy levels for the Thomas-Fermi and Thomas-Fermi-Dirac potential. Richard Latter. 10-19-54. Unclassified.

An investigation of the eigenvalues of the Schrödinger equation for the Thomas-Fermi and Thomas-Fermi-Dirac atomic potentials. Electron self-interactions are considered by modifying the potentials in order to give asymptotically the field of a unit charge, and all levels from $1s$ to $7d$ are examined for a range of Z -values sufficient to permit easy interpolation. 32 pp. Illus. Published in *The Physical Review*, July 15, 1955.

P-586. A problem in the sequential design of experiments. R. E. Bellman. 10-20-54. Unclassified.

A study to determine an optimal testing policy where gain and learning are simultaneous for the case in which the outcome of one choice is known and the other is subject to a known a priori distribution. 17 pp. Published in *Sankhyā*, April, 1956.

P-587. Social interaction. R. F. Bales. 12-14-54. Unclassified.

A paper which describes a systematic procedure for analyzing social interaction and compares what is known about the interaction process with some features of an air defense network. 22 pp. Illus. Published in *Scientific American*, March, 1955.

P-588. Fully convex normed linear spaces. K. Fan and I. L. Glicksberg. 6-17-55. Unclassified.

Some results on an analogue of uniform convexity in normal linear spaces. 16 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, November, 1955. Presented before the American Mathematical Society at Pittsburgh, Pennsylvania, December 27–30, 1954.

P-589. Dynamic programming and multistage decision processes of stochastic type. R. E. Bellman. 11-2-54. Unclassified.

A summary of some applications of the dynamic programming theory to various classes of multistage decision problems of stochastic type. 19 pp. Published in the *Proceedings of the Second Symposium on Linear Programming*, Washington, D.C., January 31, 1955.

P-590. A note on the mean value of random determinants. R. E. Bellman. 11-2-54. Unclassified.

A presentation of an explicit expression for the moments of a random determinant in order to yield a systematic technique for obtaining the moments numerically. 4 pp. Published in the *Quarterly of Applied Mathematics*, October, 1955.

P-591-AEC. Solutions of the temperature-perturbed Thomas-Fermi equation. J. J. Gilvarry and G. H. Peebles. 11-5-54. Unclassified.

An extension of previous numerical results (by using an analytical solution of the temperature-perturbed Thomas-Fermi equation) in order to determine boundary and initial parameters corresponding to seven neutral-atom zero-temperature solutions. 16 pp. Illus. Published in *The Physical Review*, July 15, 1955.

P-592. Analytical approximations, volume XVII. C. Hastings, Jr., and J. P. Wong, Jr. 11-5-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, and P-559. 6 pp. See also P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

P-593. Decisionmaking in the face of uncertainty—II. R. E. Bellman. 11-8-54. Unclassified.

An examination of multistage processes involving both zero-sum and non-zero-sum games. Approximate solutions for both classes of multistage games under various realistic assumptions are derived by using the games of survival concept. 11 pp. See Part I, P-568. Published in the *Naval Research Logistics Quarterly*, December, 1954.

P-594. Notes on matrix theory—VI. R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 11-10-54. Unclassified.

A derivation of an identity in matrix theory which yields a number of interesting inequalities. 4 pp. Published in the *American Mathematical Monthly*, October, 1955.

P-595. Analytical approximations, volume XVIII. C. Hastings, Jr., and J. P. Wong, Jr. 11-11-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, and P-592. 6 pp. See also P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

P-596. Linear programming under uncertainty. G. B. Dantzig. 3-8-55. Unclassified.

A study of a class of linear programming models where the activities are divided into two or more stages. The quantities of activities in the first stage are determined in advance, and those in the second and later stages are dependent on the outcome of random events. 19 pp. Also published as RM-1374-1. Published in *Management Science*, April-July, 1955.

P-597. Dynamic programming and a new formalism in the calculus of variations—I. R. E. Bellman. 11-15-54. Unclassified.

An investigation of various problems in the calculus of variations as continuous decision processes. It is shown how the methods of dynamic programming theory may be utilized to yield functional equations of a new type and successive approximations of the monotone type to the solutions. 28 pp. Published in *Rivista di Matematica della Università di Parma*, Vol. 6, Nos. 3-5, 1955.

- **P-598 (out of print). On a general method in the theory of inequalities.** R. E. Bellman. 3-4-55. Unclassified.

A proof that a simple device, dealing with a fundamental principle in analysis, may furnish a common basis for some interesting inequalities in various parts of analysis. 16 pp.

- **P-599. Communicating research results.** B. W. Haydon. 11-15-54. Unclassified.

A discussion of the problem of communicating research results from the standpoint of the audience, substance, and purpose of reports. Difficulties of working with pedantic and inarticulate scientists are briefly mentioned. 11 pp. Presented before the American Association for the Advancement of Science at the University of California at Berkeley, December 30, 1954.

P-600. Industry-wide, multi-industry, and economy-wide process analysis. H. M. Markowitz. 11-18-54. Unclassified.

A paper which defines process analysis, presents an example of a subanalysis, describes the difficulties of, and the aids to, the building of an economy-wide model, and compares an economy-wide process analysis model with other economy-wide models. 25 pp. Tables. Published in *The Structural Interdependence of the Economy, Proceedings of an International Conference on Input-Output Analysis*, ed. by Tibor Barna, John Wiley & Sons, Inc., New York, 1956. \$7.50.

P-601. Analytical approximations, volume XIX. C. Hastings, Jr., and J. P. Wong, Jr. 11-18-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, and P-595. 6 pp. See also P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

P-602. Concepts and computing procedures for certain X_{ij} programming problems. H. M. Markowitz. 11-19-54. Unclassified.

An application of various concepts helpful in analyzing certain X_{ij} models. Special computing techniques are presented, and the properties, solution, and application of embedded X_{ij} models are discussed. 44 pp. Illus. Published in the *Proceedings of the Second Symposium on Linear Programming*, Washington, D.C., January 27-29, 1955. Presented before the Symposium on Linear Programming at Washington, D.C., January 27, 1955.

P-603. Soviet attitudes toward modern air power. R. L. Garthoff. 11-29-54. Unclassified.

An attempt to describe the current Soviet attitude toward air power and to compare this doctrine with the U.S. viewpoint. 11 pp. Published in *Military Affairs*, Summer, 1955. Presented before the American Historical Association at Washington, D.C., December 28-30, 1954.

P-604. The impact of air power on the international scene, 1933-1940. H. S. Dinstein. 11-29-54. Unclassified.

An examination of the part that expectations, concerning the role of air power in World War II, played in international diplomacy between 1933 and 1940. 16 pp. Published in *Military Affairs*, Summer, 1955. Presented before the American Historical Association at Washington, D.C., December 28-30, 1954.

• **P-605. Maximal flow through a network.** L. R. Ford, Jr., and D. R. Fulkerson. 11-19-54. Unclassified.

A proof of the minimal cut theorem, for a general network, which determines a simple computational procedure for achieving a maximal flow in planar networks. 12 pp. Also published as RM-1400. Published in the *Canadian Journal of Mathematics*, Vol. VIII, No. 2, 1956. Presented before the Mathematical Association of America, at Santa Monica, California, March 12, 1955.

P-607. Analytical approximations, volume XX. C. Hastings, Jr., and J. P. Wong, Jr. 11-24-54. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, and P-601. 6 pp. See also P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

• **P-608. The digital computer: where does it go from here?** W. H. Ware. 10-5-54. Unclassified.

A presentation of the background of electronic computing machinery. The study discusses (1) characteristics, applications, and difficulties encountered in such machines, (2) their future trends in application, and (3) the expected advances in the technique and physical hardware and in the logical organization of these computers. 18 pp. Presented before the Institute of Radio Engineers at Los Angeles, California, September 27, 1954.

- P-609. A linear-programming solution to dynamic Leontief type models. H. M. Wagner. 8-27-54. Unclassified.

A discussion of an economic model in an attempt to determine the feasibility of certain time demand profiles, the substitution rate between economic activities occurring in different time periods, the economic growth, and the industrial cycles. A linear programming formulation of Leontief type relationships is considered, and a method for reducing computation time is proposed. 51 pp. Illus. Published in *Management Science*, April, 1957.

- P-610. A production smoothing problem. S. M. Johnson and G. B. Dantzig. 1-6-55. Unclassified.

A solution to the problem in which a single item is to be produced over a given number of time periods in order to satisfy known future requirements while minimizing costs. These costs per unit (for production, storage, and change in production rate) are assumed to be known functions of time. 28 pp. Illus. Also published as RM-1432. Published in the *Proceedings of the Second Symposium on Linear Programming*, Washington, D.C., January 27-29, 1955. Presented before the Linear Programming Symposium at Washington, D.C., January 28, 1955.

- P-611. The costs of alternative air base stocking and requisitioning policies. J. W. Petersen and M. A. Geisler. 12-7-54. Unclassified.

A study of the supply operations at a typical Air Force base in order to determine the effect upon support cost of different logistics policies involving changes in safety level and requisitioning frequency. 24 pp. Illus. A condensed version of RM-1392. Published in the *Naval Research Logistics Quarterly*, March-June, 1955. Presented before the Long-range Logistics Conference at Santa Monica, California, January 11-14, 1955.

- P-614. Elastic stress waves produced by pressure loads on a spherical shell. J. H. Huth and J. D. Cole. 3-16-55. Unclassified.

A discussion of the elastic stresses in a thin spherical shell structure occurring from the pressure loading of a blast wave. This is part of a broader investigation to determine the effect of blast waves on the structure of a missile in flight. 34 pp. Illus. Published in the *Journal of Applied Mechanics*, December, 1955. Presented before the U.S. Naval Postgraduate School at Monterey, California, September 12, 1955.

- P-615. Psychological aspects of foreign policy. H. Speier and W. P. Davison. 12-15-54. Unclassified.

A discussion of how the psychological aspect of policy in war or peace may result in success or disaster. Several factors considered are the nature of foreign policy goals, the types and instruments of power in international relations, the role of international communication, and the challenge of new weapons. 47 pp. Published as Chapter V in the "Emergency Management of the National Economy" series, Vol. 17 (*Psychological Aspects of Global Conflict*), issued by the Industrial College of the Armed Forces, Washington, D.C., 1955.

- P-616. The scientific status of propaganda analysis. A. L. George. 12-15-54. Unclassified.

An attempt to evaluate the scientific status of content analysis when used for the propaganda analysis of totalitarian communications. This paper may be useful in advancing research methodology for the scientific study of communication and in developing other policy uses of the content analysis techniques. 21 pp. Incorporated in *Propaganda Analysis*, Row, Peterson & Co., Evanston, Ill., 1959. \$6.00. Presented before the Conference on Theory and Technique of Content Analysis at the University of Illinois, Urbana, Illinois, February, 1955.

- P-617. Qualitative and quantitative procedures in content analysis. A. L. George. 12-15-54. Unclassified.

A review of the quantitative and qualitative procedures in content description used by the Federal Communications Commission for estimating totalitarian strategy during World War II. In particular, the study discusses (1) the relationship between content description and inferential hypotheses, (2) frequency and nonfrequency types of content analysis, and (3) the problem of considering language contexts in semantical content analysis. 38 pp. Incorporated in *Propaganda Analysis*, Row, Peterson & Co., Evanston, Ill., 1959. \$6.00. Presented before the Conference on Theory and Technique of Content Analysis at the University of Illinois, Urbana, Illinois, February, 1955.

P-618. Responses to material presented during various levels of sleep. C. W. Simon and W. H. Emmons. 10-10-55. Unclassified.

A description of an experiment designed to determine the effect on recall and response to material presented to subjects at various levels of awareness between wakefulness and deep sleep. 37 pp. Illus. A revised version of RM-1442. See supplement P-619. Published in the *Journal of Experimental Psychology*, February, 1956.

P-619. The nonrecall of material presented during sleep. W. H. Emmons and C. W. Simon. 10-12-55. Unclassified.

A supplement to P-618, *Responses to Material Presented during Various Levels of Sleep*. The present study emphasizes repetitive training during which it is assumed that the subject is asleep and the material presented under these conditions is not recalled. 12 pp. Table. Also published as RM-1444. Published in the *American Journal of Psychology*, March, 1956.

P-620. The chess machine: an example of dealing with a complex task by adaptation. Allen Newell. 12-28-54. Unclassified.

A discussion of how mechanisms can deal with tasks so complex that no predetermined or "brute force" program can succeed. The study analyzes the programming of a modern computer to play good chess, a performance system for a chess machine using a functional language, and some techniques and problems of coding the system for the Johnniac. 25 pp. Illus. Published in the *Proceedings of the Western Joint Computer Conference*, March 1-3, 1955. Presented before the Western Joint Computer Conference at Los Angeles, California, March 1-3, 1955.

• **P-622. On games of survival.** J. W. Milnor and L. S. Shapley. 10-10-56. Unclassified.

A proof (using the semi-martingale theory) of the existence of a value and optimal strategies in a game of survival. A simple approximation to the solution is discussed, together with several examples. 44 pp. Illus. Published in the *Annals of Mathematics Studies*, No. 38, 1956. Presented before the Princeton Games Theory Conference at Princeton, New Jersey, January 31, 1955.

P-625. A simplified expression for the dihedral effect of a flexible wing. W. P. Rodden. 1-18-55. Unclassified.

A study which determines a variation of sideslip rolling moment coefficient with load factor in order to show the dependence of the dihedral effect of a flexible wing on the gross weight and the normal load factor of an airplane. 4 pp. Published in the *Journal of the Aeronautical Sciences*, August, 1955.

P-626. On use of the general bending formula. W. P. Rodden. 1-18-55. Unclassified.

A proof of the general unsymmetrical bending formula for plane stress. Three equations of section equilibrium are solved simultaneously without simplifying the centroidal coordinates, thereby saving computing time and memory space required for stress calculations on a high-speed digital computer. 4 pp. Published in the *Journal of the Aeronautical Sciences*, July, 1955.

• **P-629. Markets as cooperative games.** L. S. Shapley. 3-7-55. Unclassified.

A description of how numerous market situations can be formulated as cooperative games in the von Neumann-Morgenstern theory. The solutions of several examples are discussed, and an abstract market game is defined generally. 6 pp. Presented before the Princeton Games Theory Conference at Princeton, New Jersey, February 1, 1955.

P-631. Notes in the theory of dynamic programming—II: a functional equation arising in allocation theory. R. E. Bellman. 1-25-55. Unclassified.

A description of the solution of a functional equation. The method of successive approximations is used. 8 pp. Published in the *Journal of the Society for Industrial and Applied Mathematics*, September, 1955.

P-632. Notes in the theory of dynamic programming—III: equipment replacement policy. R. E. Bellman. 1-26-55. Unclassified.

An application of the functional equation technique of the dynamic programming theory to that of equipment replacement. 7 pp. Illus. Published in the *Journal of the Society for Industrial and Applied Mathematics*, September, 1955.

P-633. A similarity solution for a spherical shock wave. Richard Latter. 2-3-55. Unclassified.

A proof (using the viscosity technique) that in the limit of infinite shock strength, a point-source spherical shock flow has a similarity solution for a γ -law gas. The solution considered is determined by the numerical and analytic integration of the ordinary differential equations resulting from the similarity of the flow. 24 pp. Tables. Also published as RM-1435. Published in the *Journal of Applied Physics*, August, 1955.

P-634. A stockpiling problem: mathematical treatment. J. M. Danskin, Jr. 2-23-53. Unclassified.

A presentation of necessary conditions on the solution, if there is one, for the general case of a stockpiling problem. A complete solution is obtained for a special case. 18 pp. Also published as RM-1045. Published in the *Naval Research Logistics Quarterly*, March-June, 1955.

P-635. Perturbation methods in applied mathematics. R. E. Bellman. 2-10-55. Unclassified.

A presentation of a simple technique for increasing the range of effectiveness of perturbation and power series methods in situations in which the equations treated contain parameters that assume only positive values. 13 pp. Published in the *Quarterly of Applied Mathematics*, July, 1955.

P-636. Some nonclassical problems in the calculus of variations. R. E. Bellman, I. L. Glicksberg, and O. A. Gross. 2-17-55. Unclassified.

An application of the min-max theorem of game theory to the solution of some classes of variational problems involving nonanalytic functionals. 13 pp. Published in the *Proceedings of the American Mathematical Society*, February, 1956.

P-637. The optimization of a quadratic function subject to linear constraints. H. M. Markowitz. 6-27-55. Unclassified.

A computing technique for generating several efficient sets of combinations of the expected value, and the variance of the payoff. While this study discusses only minimization problems involving a quadratic form whose matrix is positive semi-definite, this technique may be adapted for problems of maximizing or minimizing quadratic forms (with the right properties) subject to linear constraints. 34 pp. Illus. Also published as RM-1438. Published in the *Naval Research Logistics Quarterly*, June, 1956.

P-638. A study of the structure of the ionosphere. H. K. Kallmann. February 1955. Unclassified.

A theoretical description of the ionosphere which agrees closely with experimental data. The physical processes responsible for ionization in the upper atmosphere are investigated, together with their effects in producing ionized layers. 162 pp. Illus. Published in *The Physical Review*, April 1, 1953. Presented before the Physical Society at New York City, January 31, 1956.

P-639. Variational problems with constraints. R. E. Bellman, W. H. Fleming, and D. V. Widder. 2-23-55. Unclassified.

The maximization of an integral with certain constraints. The structure of the solution is discussed. 39 pp. See also RM-1430. Published in *Annali di Matematica*, Series IV, Vol. XLI, 1955.

P-640. Notes in the theory of dynamic programming—IV: a variational problem with constraints. R. E. Bellman. 2-28-55. Unclassified.

An attempt to determine how the functional equation technique of the dynamic programming theory may be used to solve a class of variational problems with constraints. 24 pp. Illus. See P-721. Published in the *Journal of the Society for Industrial and Applied Mathematics*, March, 1956.

• **P-641. Creep buckling: an engineering survey.** F. R. Shanley. June 1954. Unclassified.

A review of the present status of creep-buckling theory in relation to the development of column theory. The iso-tangent-modulus method and its application to various types of buckling and design problems are considered, and future analytical and experimental work on creep-buckling is suggested. 52 pp. Illus. Presented at the Pennsylvania State University, State College, Pennsylvania, June 28-July 1, 1954.

P-642. The problem of aiming and evasion. R. P. Isaacs. 3-14-55. Unclassified.

A discussion of the general evasion game with a time lag in the information that the marksman has as to the target position. An example is presented in which the marksman has no optimal strategy. 42 pp. Illus. A condensed version of RM-1385. Published in the *Naval Research Logistics Quarterly*, March-June, 1955.

- **P-644-AEC. The Lindemann and Grüneisen laws.** J. J. Gilvarry. 3-23-55. Unclassified.

A proof that the Lindemann fusion law can be derived from the theory of the temperature dependence of Bragg reflection of X-rays. This law, together with the Grüneisen theory of solids, is used in order to determine the Grüneisen constant of the solid at melting in terms of fusion parameters. 32 pp. Illus. Published in *The Physical Review*, April 15, 1956.

P-645. Radiation patterns of unsymmetrically fed prolate spheroidal antennas. H. A. Myers. 8-18-55. Unclassified.

A description of the radiation pattern of the unsymmetrically fed prolate spheroidal transmitting antenna. Maxwell's equations are solved in prolate spheroidal coordinates subject to the boundary conditions, and the prolate spheroidal functions are expressed by power and Laurent series. 18 pp. Illus. Published in the *Institute of Radio Engineers—Transactions on Antennas and Propagation*, January, 1956. Presented before the Western Electronics Show and Convention at San Francisco, California, August 24, 1955.

- **P-646. The application of statistical methods to the design and analysis of experiments.** D. S. Stoller. 3-22-55. Unclassified.

A survey of the criteria, designs, and analyses of tests (in statistics and operations research) which are applicable to experimental design and analysis. 11 pp. Illus. Published in *Proving Ground Instrumentation*, 1955, ed. by H. C. Carroll and W. A. Wildhack, American Ordnance Association, Washington, D.C., June, 1955. Presented before the American Ordnance Association at Patrick Air Force Base, Florida, April 14-15, 1955.

P-647. An optimal inventory policy for a military organization. E. B. Berman and A. J. Clark. 3-30-55. Unclassified.

A presentation of an optimal inventory policy for a military organization consisting of bases and depots. It is assumed that the military objective is to minimize the sum of the costs of logistics support and the costs of a pool of end items being out of commission for parts. 83 pp. Illus. Presented in part before the Operations Research Society of America at Monterey, California, August 17, 1956.

P-648. The fixed charge problem. W. M. Hirsch and G. B. Dantzig. 12-1-54. Unclassified.

A discussion of the properties of a general solution to a fundamental unsolved problem in the programming area. This problem is one in which various activities have fixed charges (e.g., setup time charges) if operating at a positive level. 21 pp. Also published as RM-1383.

- **P-649. An activity analysis approach to location theory.** M. Beckmann and T. A. Marschak. 4-5-55. Unclassified.

An application of linear activity analysis to short-run locational problems by determining (1) the profit-maximizing locational decisions of a firm operating given branch plants and (2) the efficient and attainable distributions of final commodities over the regions constituting an economy whose plants and resources are given. 38 pp. Illus. Published in the *Proceedings of the Second Symposium on Linear Programming*, Washington, D.C., January 27-29, 1955.

- **P-650-AEC. Grüneisen's law and the fusion curve at high pressure.** J. J. Gilvarry. 4-11-55. Unclassified.

A method to determine the correction to Grüneisen's law corresponding to the effect of the electrons at high pressure. It is assumed that the lattice contribution to the pressure is small and that the equation of state of the solid can be approximated by results of the statistical Thomas-Fermi atom model for the electron pressure. 29 pp. Illus. Published in *The Physical Review*, April 15, 1956.

P-651. Mathematical aspects of scheduling theory. R. E. Bellman. 5-23-55. Unclassified.

An attempt to describe numerous representative problems in the field of scheduling. In addition, the methods devised to treat these problems are discussed. 61 pp. Published in the *Journal of the Society for Industrial and Applied Mathematics*, September, 1956.

P-652. Recent advances in linear programming. G. B. Dantzig. 4-12-55. Unclassified.

A discussion of such developments in linear programming as uncertainty, combinatorial problems, and large-scale systems. 31 pp. Also published as RM-1475. Published in *Management Science*, January, 1956.

P-653. A transition model laboratory for research on cultural change. J. L. Kennedy. 12-8-55. Unclassified.

A discussion of the design and development of a new model of aircraft. This paper attempts to show how the gap may be lessened between laboratory and field studies of cultural change in order that the results at the laboratory level may be helpful in determining similar phenomena in the expanded context of field conditions. 13 pp. Published in *Human Organization*, Fall, 1955. Presented before the Society of Applied Anthropology at Bloomington, Indiana, May 6, 1955.

P-654. An aeroelastic parameter for estimation of the effects of flexibility on the lateral stability and control of aircraft. W. P. Rodden. 4-14-55. Unclassified.

A study of an aeroelastic parameter in an attempt to estimate the flexibility effects on the maneuvering performance of an aircraft from the losses in lateral control and stability at high speeds. In addition, the modification of conventional stability derivatives to include the steady-state effects of flexibility is considered, together with the determination of aileron reversal speed and applications for preliminary design. 12 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, July, 1956.

● **P-655. The EEG, consciousness, and sleep.** C. W. Simon and W. H. Emmons. 4-15-55. Unclassified.

An attempt to relate specific electroencephalography (EEG) patterns along the continuum between waking and deep sleep with the ability to respond and remember, the criteria used as a measure of consciousness. Alpha-dominant subjects were used in order to differentiate EEG patterns during the period between complete wakefulness and the first stages of sleep. 26 pp. Illus. Published in *Science*, November 30, 1956.

P-656. Numerical solutions of the Thomas-Fermi statistical model. Richard Latter. 4-15-55. Unclassified.

A presentation of solutions of the zero-temperature Thomas-Fermi equation for an atomic system. The complete range of atomic volumes of physical interest is considered, sufficient to permit accurate interpolation to intermediate regions. Tables are given of the potential distributions as well as of the important physical properties. 23 pp. Illus. Published in *The Journal of Chemical Physics*, February, 1956.

● **P-657. The Systems Research Laboratory and its program.** J. L. Kennedy. 10-17-55. Unclassified.

A paper concerning the objectives of the Systems Research Laboratory and its role in studying complex systems interactions. 4 pp. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

● **P-658. Description of the air-defense experiments—III: data collection and processing.** R. L. Chapman. 10-17-55. Unclassified.

A description of data collection and data processing techniques which influence the methodology of the Systems Research Laboratory studies. In addition, various problems involved in the experiment are considered. 5 pp. See also P-659 and P-661. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

- **P-659. Description of the air-defense experiments—II: the task environment.** Allen Newell. 10-17-55. Unclassified.

A discussion of the construction of an environmental situation appropriate to the task it is attempting and with sufficient control for obtaining useful data about performance of the system relative to the task. 4 pp. See also P-658 and P-661. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

- **P-660. Systems behavior—II: the developmental process.** M. G. Weiner. 10-17-55. Unclassified.

A paper which discusses various aspects of the organizational development of a model and provides a part of the schema of data analysis. 5 pp. Illus. See also P-662. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

- P-661. Description of the air-defense experiments—I: the physical and cultural environments.** W. C. Biel. 10-17-55. Unclassified.

A discussion of how laboratory environments should be represented and maintained. 6 pp. See also P-658 and P-659. Published as "Experimental Conditions" in *The American Psychologist*, August, 1955. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

- **P-662. Systems behavior—I: the learning process.** L. T. Alexander. 10-17-55. Unclassified.

An evaluation of the training progress in a complex system. The sequences of conditions producing certain functional classes are investigated, together with the levels of organizational development in terms of the classes characterizing the various levels. 3 pp. Illus. See also P-660. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

- P-663-AEC. Stark fields from ions in a plasma.** A. A. Broyles. 3-28-55. Unclassified.

A method to determine the probability of obtaining a given electric field on an ion in a plasma. This quantity is essential for computing the broadening of spectral lines from neighboring ions and for their contribution to the opacity. 22 pp. Illus. Published in *The Physical Review*, November 15, 1955.

- P-664. A general transformation for orthotropic plane stress and plane strain problems.** H. A. Lang. 5-23-55. Unclassified.

A proof that two simple transformations extend immediately the solution of any isotropic plane stress or plane strain problem to the solution of a similar orthotropic problem. It is assumed that the orthotropic plane body is defined by four independent elastic constants. 18 pp. Illus. Published in the *Journal of Applied Mechanics*, March, 1956. Presented before the American Society of Mechanical Engineers at the U.S. Postgraduate School, Monterey, California, September 13, 1955.

- P-665. The role of mass communications during the Berlin blockade.** W. P. Davison. 4-22-55. Unclassified.

A study of the role that mass communications played during the Berlin blockade and airlift of 1948-49. The author suggests that mass communications, rather than an instrument of manipulation operating from outside the social system, were significant as part of the machinery within the social system. 12 pp. Published as "Political Significance of Recognition via Mass Media—An Illustration from the Berlin Blockade" in *The Public Opinion Quarterly*, Spring, 1956. Presented before the Tenth Annual Conference on Public Opinion Research at Madison, Wisconsin, April 14, 1955.

- P-666. A proposed mechanism of fatigue failure.** F. R. Shanley. 4-11-55. Unclassified.

A description of a proposed mechanism of unbonding during reversed slip in order to determine what causes cracking to occur under repeated loading. 19 pp. Illus. Also published as RM-1476. Presented before the International Union of Theoretical and Applied Mechanics at Stockholm, Sweden, May 25-27, 1955, and published in the proceedings of the colloquium.

P-667. Temperature behavior of the Thomas-Fermi statistical model for atoms. Richard Latter. 4-25-55. Unclassified.

An attempt to determine the thermodynamic properties of all elements over a wide range of temperatures and densities by solving nonlinear differential equations of the Thomas-Fermi atomic model. Some analytic properties of the Thomas-Fermi equations are investigated, and certain approximate analytic solutions are derived for limiting cases. 41 pp. Illus. Published in *The Physical Review*, September 15, 1955.

P-669. The influence of mass destruction weapons on strategy. Bernard Brodie. 3-21-55. Unclassified.

A lecture (presented before the Army War College, Carlisle Barracks, Pennsylvania, March 21, 1955) concerning the influence of thermonuclear weapons in terms of strategic and tactical use. The author states that with the speed and magnitude of destruction available through the steadily growing stockpiles of nuclear weapons, any unrestricted war between the major powers must have a character and a conclusion that are predetermined by the war plans existing at the outset. 23 pp. Published in condensed form as "Strategy Hits a Dead End" in *Harper's*, October, 1955.

P-671. Functional equations in the theory of dynamic programming—II: nonlinear differential equations. R. E. Bellman. 5-5-55. Unclassified.

A summary of some basic results concerning the existence and uniqueness of solutions of the equation $dx/dt = \max_q f(x, t; q)$. 5 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, July, 1955.

P-672. Line broadening by electrons: the validity of simple theories. R. E. Meyerott and H. Margenau. 5-9-55. Unclassified.

A comparison of the simple impact theories of line broadening by electrons with the detailed computations of Kivel, Bloom, and Margenau. 12 pp. Illus. Published in *The Physical Review*, September 15, 1955. Presented before the American Physical Society at New York City, January 29, 1955.

P-674. Some thoughts on the social structure after a bombing disaster. Jack Hirshleifer. 8-18-55. Unclassified.

A discussion of various elements in predicting the social and political consequences of a large-scale bombing attack. This paper examines the effects of a bombing upon the organization of society, the distribution of political and economic power, and the institutions relevant to the effective functioning of society. 30 pp. Published in *World Politics*, January, 1956.

P-676. Functional equations in the theory of dynamic programming—III: multistage games. R. E. Bellman. 3-14-56. Unclassified.

An attempt to determine existence and uniqueness theorems for a class of functional equations occurring in the theory of multistage games. 31 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series II, Vol. V, 1956.

• **P-677. Computation of maximal flows in networks.** D. R. Fulkerson and G. B. Dantzig. 4-1-55. Unclassified.

A proposal of a simple computational method—based on the simplex algorithm of linear programming—to determine a maximal flow between two given points in a transportation network. 17 pp. Illus. Also published as RM-1489. Published in the *Naval Research Logistics Quarterly*, December, 1955.

P-678. Čech compactifications of products. I. L. Glicksberg. 5-16-55. Unclassified.

A discussion of some easily determined relationships between pseudo-compactness and Čech compactification of certain product spaces. 6 pp.

P-680. The elimination form of the inverse and its application to linear programming. H. M. Markowitz. 4-8-55. Unclassified.

A discussion of a particular product form of inverse which is closely related to the Gaussian elimination method of solving a set of simultaneous equations. 18 pp. Illus. Also published as RM-1452. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-681. Note on a theorem of Dilworth. D. R. Fulkerson. 4-11-55. Unclassified.

A proof that Dilworth's theorem on chain decompositions of partially ordered sets is deduced from Menger's theorem concerning linear graphs. 5 pp. Published in the *Proceedings of the American Mathematical Society*, August, 1956.

P-682-AEC. The equation of the fusion curve. J. J. Gilvarry. 5-24-55. Unclassified.

A generalization of the Lindemann law, used in connection with the Murnaghan equation of state for a solid. A law of reduced states for fusion is derived which is valid for the case of classical excitation of the lattice vibrations at melting. 23 pp. Illus. Published in *The Physical Review*, April 15, 1956.

P-684. The Soviet high command and general staff. R. L. Garthoff. 5-27-55. Unclassified.

A paper on the organization of the armed forces under the Soviet Ministry of Defense. The General Staff, the *Stavka*, the military districts and groups of forces, and the political controls in the Russian armed forces are described. 18 pp. Illus. Published as *The Soviet Army*, ed. by B. H. Liddell Hart, Weidenfeld and Nicolson, London, 1956. 36 s. (\$5.04). Also published as *The Red Army*, Harcourt, Brace & Co., New York, 1956. \$6.00.

P-685. Linear programming and economic theory. P. A. Samuelson. 5-25-55. Unclassified.

A discourse on the development of linear programming in economic theory. This paper describes the sources of data on linear programming, the theoretical insights it provides, the existence of competitive equilibrium, and the power of advanced methods. 17 pp. Published in the *Proceedings of the Second Symposium on Linear Programming*, Washington, D.C., January 27-29, 1955. Presented before the Linear Inequalities Conference at Washington, D.C., January 28, 1955.

P-686. A description of a cooperative venture in the production of an automatic coding system. W. S. Melahn. 9-27-55. Unclassified.

An evaluation of several ideas, suggested by the Project for the Advancement of Coding Techniques, for improving the programming of problems for machine solution. 10 pp. Published in the *Journal of the Association for Computing Machinery*, October, 1956. Presented before the Association for Computing Machinery at Philadelphia, Pennsylvania, September 15, 1955.

P-687. Determination of the maximal steady state flow of traffic through a railroad network. A. W. Boldyreff. 8-5-55. Unclassified.

A method of estimating the maximal steady state flow of traffic through a railroad network. 36 pp. Illus. Published in the *Journal of the Operations Research Society of America*, November, 1955. Presented before the Operations Research Society of America at New York City, June 3, 1955.

• **P-688. Computing experience with linear programming and its variants.** William Orchard-Hays. 8-8-55. Unclassified.

A discussion of RAND's simplex codes for the IBM 701, together with the prospects for future improvements in theory and coding techniques. 13 pp. Presented before the Association of Computing Machinery at the University of Pennsylvania, Philadelphia, Pennsylvania, September 15, 1955.

P-689-RC. Criteria for the selection of water-resource projects. R. N. McKean. 9-16-55. Unclassified.

A discussion of certain problems of a cost-benefit analysis of water-resource projects (e.g., irrigation, flood-control, and soil conservation measures). 15 pp. Illus. Published in the *Journal of the Operations Research Society of America*, February, 1956. Presented before the Operations Research Society of America at Los Angeles, California, August 16, 1955.

• **P-690. A system for cataloguing reference material.** R. P. Johnson, D. J. Blakeslee, and H. Skavdahl. 6-7-55. Unclassified.

An attempt to reduce the time spent in obtaining information on a given subject by a system of cataloguing reference material. This system permits a quick examination of an itemized summary of the pertinent reports available. 11 pp. Illus.

- **P-691. File reference.** J. A. Postley. 8-18-55. Unclassified.

A discussion of the problem of efficient reference to information filing associated with large-scale electronic data processing systems. 19 pp. Illus. Presented before the Association for Computing Machinery at Philadelphia, Pennsylvania, September 14, 1955.

- **P-692. PACT loop expansion.** G. S. Hempstead and J. I. Schwartz. 10-31-55. Unclassified.

A discussion of the coding techniques used in the loop generation routine of PACT I (Project for Advanced Coding Techniques). This program is designed to produce an efficient machine language code for the 701 computer from a description of the steps in a calculation. 15 pp. Tables. Published in the *Journal of the Association for Computing Machinery*, October, 1956. Presented before the Association of Computing Machinery at the University of Pennsylvania, Philadelphia, Pennsylvania, September 15, 1955.

- **P-693. Semi-automatic allocation of data storage for PACT I.** J. I. Derr and R. C. Luke. 10-10-55. Unclassified.

A discussion of the system developed for realizing the allocation of high-speed memory for all data referenced in PACT instructions. PACT I is a program designed to produce an efficient machine language code for the 701 computer. 17 pp. Illus. Published in the *Journal of the Association for Computing Machinery*, October, 1956. Presented before the Association for Computing Machinery at Philadelphia, Pennsylvania, September 15, 1955.

- P-694. The role of management tools in making military decisions.** D. Novick and G. H. Fisher. 6-16-55. Unclassified.

An attempt to examine the basic types of military decision-making areas and to relate the auxiliary tools of key management decisions to these areas. In addition, military decisions concerning research and development, procurement, and operations are discussed. 27 pp. Published in *Armed Forces Management* in the September, October, and November, 1956, issues. Presented before the USAF World-wide Management Analysis Conference at Langley Air Force Base, Virginia, May 20, 1955.

- P-695. Calculation of hydrofoil sections from prescribed pressure distributions.** B. R. Parkin and G. H. Peebles. 6-16-55. Unclassified.

A manual for designing hydrofoils or airfoils from specifications on the pressure distributions. The Mangler method considered employs the theories of incompressible, inviscid, steady flow, and conformal transformations. Both theory and numerical procedure are developed in an attempt to determine a more general application for this profile design method. 165 pp. Illus.

- P-696. Some aspects of the theory of dynamic programming.** R. E. Bellman. 6-23-55. Unclassified.

An introduction to the use of dynamic programming theory in treating multistage decision processes. A maximization problem of conventional type is considered, together with a decision process involving random or chance events. 13 pp.

- P-697. Britain and the defense of Western Europe.** H. A. De Weerd. 6-20-55. Unclassified.

A review of Britain's traditional policies toward Western European defense. With particular emphasis on the period since 1945, Britain's attitudes concerning air power, atomic weapons, deterrence, and NATO are discussed. In addition, this study considers British dependability as a U.S. ally and the effects of future weapon development. 34 pp. Published as "Britain's Changing Military Policy" in *Foreign Affairs*, October 1955.

- P-698. The topology of the finitary approximation.** D. O. Ellis. 8-2-55. Unclassified.

A study of a topology in the space of functions mapping an arbitrary set into an arbitrary metric space. It is assumed that the topology has as many accumulation points as pointwise convergence. 11 pp. Presented before the American Mathematical Society at Ann Arbor, Michigan, September 2, 1955.

P-699. An appreciation of systems analysis. C. J. Hitch. 8-18-55. Unclassified.

A description of military systems analysis as a framework for combining the knowledge of experts in many fields to reach solutions which transcend any individual expert's judgment. 26 pp. Published in the *Journal of the Operations Research Society of America*, November, 1955. Presented before the Operations Research Society of America at Los Angeles, California, August 15, 1955.

P-700. Remarks on the design, conduct, and analysis of large air exercises. N. C. Peterson. 5-16-55. Unclassified.

A transcript of a talk presented before the Tenth Operations Analysis Technical Conference at Eglin Air Force Base, Florida, May 10, 1955. The ideal practices to use in large Air Force exercises are discussed with particular reference to those exercises connected with the study of tactics for offensive forces. 21 pp.

P-701-AEC. Ionization of radioactive particles in the free air. S. M. Greenfield. 7-5-55. Unclassified.

An analysis of the degree of ionization of radioactive particles from an atomic cloud in an attempt to evaluate their possible role as condensation nuclei. In particular, such questions are discussed as whether the individual particles in a radioactive cloud become ionized, and, if so, whether they remain charged for any time period. 14 pp. See R-309. Published in the *Journal of Geophysical Research*, March, 1956.

• **P-702 (out of print). On a new class of functional equations in analysis.** R. E. Bellman. 7-5-55. Unclassified.

A description of several new classes of functional equations arising from the mathematical theory of multistage decision processes. 17 pp.

• **P-703 (out of print). On the computational solution of some large-scale dynamic programming processes.** R. E. Bellman. 10-12-55. Unclassified.

An examination of several problems that arise in the computational solution of dynamic programming processes involving large numbers of independent variables. 19 pp. Illus. Presented before the Society of Industrial and Applied Mathematics at Ann Arbor, Michigan, August 31, 1955.

P-704. Functional equations in the theory of dynamic programming—V: positivity and quasi-linearity. R. E. Bellman. 7-11-55. Unclassified.

A presentation of conditions under which the solutions of $u(p) = \max_q [L(u, p, q) + a(p, q)]$ may be written $u(p) = \max_q v(p, q)$, where $v(p, q)$ is the solution of $v(p) = L(v, p, q) + a(p, q)$ for arbitrary $q = q(p)$. 6 pp. See P-1125. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, October, 1955.

• **P-705 (out of print). Functional equations in the theory of dynamic programming—IV: multistage decision processes for continuous type.** R. E. Bellman. 7-12-55. Unclassified.

A discussion of a class of nonlinear differential equations occurring in multistage decision processes of continuous type. Some difficulties encountered are considered, and the processes modeled upon the Riemann definition of the integral are defined. 27 pp.

P-706. Reduction of constrained maxima to saddle-point problems. K. J. Arrow and L. Hurwicz. 7-7-55. Unclassified.

A proof that even when the functions are not concave, a weakened form obtains locally of the result of Kuhn and Tucker that finding the constrained maximum of a concave function is equivalent to determining the saddle point of a Lagrangian expression. This result has an economic interpretation in permitting a decentralized method for achieving optimum resource allocation when there are increasing returns to scale in the economy. 46 pp. Published in the *Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability—Volume V: Contributions to Econometrics, Industrial Research, and Psychometry*, ed. by Jerzy Neyman, University of California Press, Berkeley, 1956. \$5.75. Presented before the Symposium on Mathematical Statistics and Probability at Berkeley, California, July 8, 1955.

- **P-707. Project RAND.** F. R. Collbohm. 3-24-55. Unclassified.

A paper concerning such aspects of Project RAND as (1) its origin and development, (2) its relation to the Air Force, (3) its military work with industry and universities, (4) the formulation of its research program, and (5) the communication of its research results to the Air Force and other interested agencies. 13 pp. Presented before the USAF Scientific Advisory Board at Santa Monica, California, March 24, 1955.

- **P-708. The psychologist in interdisciplinary research.** H. H. Harman. 7-25-55. Unclassified.

A discourse on the role of the psychologist in interdisciplinary research. In particular, this paper discusses the RAND System Training Project as an applied effort in combining many skills to solve problems regardless of the implied classical disciplines. 8 pp. Presented before the American Psychological Association at San Francisco, California, September 5, 1955.

- **P-710. Some observations on factor analysis.** H. H. Harman. 7-27-55. Unclassified.

An attempt to trace the origin and growth of the psychological theories and mathematical foundations of factor analysis and to appraise its present status. 8 pp. Presented before the Biometric Society at Pasadena, California, June 23, 1955.

- **P-711. On the solution of discrete programming problems.** A. S. Manne and H. M. Markowitz. 2-9-56. Unclassified.

A method for solving optimization problems in which some or all variables assume integral values. In addition, several applications are presented. 45 pp. Illus. Published in *Econometrica*, January, 1957.

- P-712. A theorem on description adequacy.** D. O. Ellis. 8-2-55. Unclassified.

A discussion of several propositions concerning the adequacy of certain classes of nets in a topological space to describe the topology of the space. 6 pp.

- P-713. A note on the dynamics of a disordered linear chain.** R. E. Bellman. 8-3-55. Unclassified.

A proof of the essential limit relation used by F. J. Dyson in determining the distribution function of the characteristic frequencies of a disordered linear chain in the limit as the chain becomes infinitely long. 4 pp. Published in *The Physical Review*, January, 1956.

- P-714. On a class of variational problems.** R. E. Bellman. 8-3-55. Unclassified.

A study to determine the minimum of a certain functional using the functional equation technique of the dynamic programming theory. 13 pp. Published in the *Quarterly of Applied Mathematics*, January, 1957.

- **P-715. Notes on matrix theory—IX.** R. E. Bellman. 1-26-56. Unclassified.

The establishment of a concavity theorem for power products of a certain form, using a generalization of an identity of Siegel. 6 pp. Published in the *American Mathematical Monthly*, March, 1957.

- P-716. On a generalization of some integral identities due to Ingham and Siegel.**
R. E. Bellman. 8-8-55. Unclassified.

An evaluation of the generalizations of multidimensional integrals due to Ingham and Siegel. In addition, some applications of these results are presented. 15 pp. Published in the *Duke Mathematical Journal*, December, 1956.

- P-717. On differential games with integral payoff.** L. D. Berkovitz and W. H. Fleming. 8-10-55. Unclassified.

A paper which, by using methods of the calculus of variations, obtains the necessary conditions such that differential games of a certain type have a saddle-point. By strengthening the necessary conditions, sufficient conditions for the existence of a saddle-point and a method of constructing the saddle-point are derived. 33 pp. Illus. Published in *Annals of Mathematics Studies*, No. 38, 1958.

P-718. The problem of continuous programs. H. A. Osborn. 8-12-55. Unclassified.

A presentation of a certain convergence theorem under specific assumptions on the form of the difference equations which define the process, rather than on their solutions. 18 pp. Published in the *Pacific Journal of Mathematics*, Winter, 1956.

P-719. Conclusions after using the PACT-1 advanced coding technique. I. D. Greenwald and H. G. Martin. 10-4-55. Unclassified.

A comparison of the PACT-1 Advanced Coding Technique (as used on the IBM 701 Data Processing Machine) with machine language coding. Such aspects are examined as coding and debugging time, number and types of errors, and coding experience required. 10 pp. Published in the *Journal of the Association for Computing Machinery*, October, 1956. Presented before the Association for Computing Machinery at Philadelphia, Pennsylvania, September 15, 1955.

● **P-720. Demographic interaction analysis and its bearing on small group studies.** F. C. Iklé. 8-17-55. Unclassified.

An investigation of the factors affecting the frequency of interactions between spatially separated areas. 12 pp. Presented before the American Sociological Society at Washington, D.C., September 1, 1955.

P-721. Notes on the theory of dynamic programming—V: maximization over discrete sets. R. E. Bellman. 12-12-55. Unclassified.

A continuation of P-640 which considers a variational problem with constraints. The present study applies the dynamic programming theory to a class of problems involving maximization over discrete sets. It is assumed that the solution depends on the solution of a class of functional equations. 6 pp. Published in the *Naval Research Logistics Quarterly*, March and June, 1956, issues.

P-722. Families of transformations in the function spaces H^p . Peter Swerling. 8-19-55. Unclassified.

A study of groups and semi-groups of transformations in the function spaces H^p , considered as Banach spaces. 36 pp. Published in the *Pacific Journal of Mathematics*, Summer, 1957.

● **P-723. On the stability of a circular cylinder at hypersonic speeds.** J. L. Raymond and T. B. Garber. 1-9-56. Unclassified.

A discussion of a single-degree-of-freedom motion of a rigid right circular cylinder (i.e., rotation about any axis normal to the longitudinal axis). The aerodynamic static and damping stability of the cylinder is used in the equations of motion for cases in which (1) the translational velocity vector and the longitudinal axis form the plane of rotation and (2) the longitudinal axis lies in the plane of rotation perpendicular to the translational velocity vector. 22 pp. Illus.

P-724. Cargo density variations: a challenge to air transport. R. E. Bickner. 8-24-55. Unclassified.

An attempt to improve the efficiency of airlift operations by examining (1) the significance of cargo densities in the various phases of airlift operations, (2) the mistakes resulting from the assumption that densities are constant, and (3) the methods by which cargo densities can be appropriately considered. 20 pp. Illus. A condensed version of RM-1380. See also RM-1853. Presented before the National Security Industrial Association at New York City, September 28, 1955.

P-725. A note on randomized branch sampling. A. W. Marshall. 8-26-55. Unclassified.

A discussion of the operation of randomized branch sampling, the relation between this sampling plan and importance sampling developed in Monte Carlo calculations, and some improvements to Jensen's theory based upon the identity of these methods. 6 pp.

P-726. Recent trends in Soviet military policy. R. L. Garthoff. 8-30-55. Unclassified.

A discussion of the Russian attempt to ease international tension by recently reducing their armed forces. The author suggests their primary objective is designed to reallocate manpower resources from an overstrong sector of national power to the understrength economic sector, balance the ground forces between the Soviet bloc and NATO, and demonstrate the "new look" in Soviet strategic thinking. 18 pp. Published in *The U.S. Army Combat Forces Journal*, October, 1955.

P-727. The allocation of aircraft to routes: an example of linear programming under uncertain demand. A. R. Ferguson and G. B. Dantzig. 12-7-56. Unclassified.

An application of linear programming to the problem of allocating aircraft to routes so as to maximize expected profits when there is uncertain customer demand. It is assumed that (1) the demand for each activity over the pertinent time period, while not known, can be estimated as a distribution of values and (2) each of these values has a specified probability of being the actual value. 41 pp. Tables. Also published as RM-1833. Published in *Management Science*, October, 1956. Presented before the Institute of Management Sciences at New York City, October 20, 1955.

P-728. The existence of stationary measures for certain Markov processes. T. E. Harris. 8-31-55. Unclassified.

A proof that a certain type of recurrence condition implies the existence of a possibly infinite stationary measure. In addition, several applications are discussed. 29 pp. Published in the *Proceedings of the Third Berkeley Symposium on Mathematical Statistics and Probability—Volume II: Contributions to Probability Theory*, ed. by Jerzy Neyman, University of California Press, Berkeley, 1956. \$6.50.

P-729. Industrial training in the Soviet Union. Walter Galenson. 8-31-55. Unclassified.

A discussion of Soviet vocational training since 1921. In particular, this study considers the magnitude of the industrial training program, the forms of direct factory training, the formal vocational education, and the dissemination of technical information within the USSR. 42 pp. Tables. Also published as RM-1479. Published in the *Industrial and Labor Relations Review*, July, 1956.

• **P-730. A systematic approach to a class of problems in the theory of noise and other random phenomena—II: examples.** A. J. F. Siegert. 9-1-55. Unclassified.

A proof that for Markoff processes, other than the Gaussian processes, certain functionals are determined for which the problem of finding the characteristic function reduces to differential equations with only the time as an independent variable. 24 pp. See also P-738 and P-939. Published in the *IRE Transactions on Information Theory*, March, 1957.

• **P-731. A new technique for eigenvalue problems—I.** H. A. Osborn. 9-2-55. Unclassified.

A discussion of a functional equation for the variational problem associated with the lowest eigenvalue in $[0, 1]$ of a certain differential equation. The development is similar to that of Bellman's formalism for nonisoperimetric variational problems in the calculus of variations. 21 pp. Presented before the American Mathematical Society at Houston, Texas, December 27-29, 1955.

P-732. Line width problems in hot dense atmospheres. R. E. N. Meyerott. 9-6-55. Unclassified.

A discussion of line width problems arising from such conditions of temperature and density as are found in stellar interiors. In addition, the possibilities of experimental verification are considered. 14 pp. Illus. Presented before the University of Pittsburgh at Pittsburgh, Pennsylvania, September 15-17, 1955.

• **P-733. Scientific use of an artificial satellite.** H. K. Kallmann, W. W. Kellogg, R. R. Rapp, and S. M. Greenfield. 9-6-55. Unclassified.

A discussion of the types of data obtainable from an artificial satellite, their practical applications to such fields as radar and communications, and the requirements for satellite orientation which are correlated with various types of observation. 22 pp. A condensed version of RM-1500. Published in the *Bulletin of the American Meteorological Society*, January, 1957. Presented before the American Meteorological Society at New York City, January 23, 1956.

P-734. Comments on future military air transport requirements. S. E. Eastman. 9-7-55. Unclassified.

A speech presented before the National Defense Transportation Association at Boston, Massachusetts, October 12, 1955. The movement of passengers and cargo for the military establishment overseas during war and peace is discussed for the period 1957-1965. 7 pp. Abstracted in the *National Defense Transportation Journal*, November-December, 1955.

- **P-735. On the partition of the vertices of an n -cube by an $(n - 1)$ -plane.** S. S. Cairns. 9-7-55. Unclassified.

A discussion of a problem arising in connection with airlift and machine scheduling. This study attempts to determine how to characterize the convex hull of the vertices of an n -cube that lie on one side of an $(n - 1)$ -plane. 18 pp. Presented before the American Mathematical Society at Houston, Texas, December 27-29, 1955.

- **P-736. Balance scale sorting.** S. S. Cairns. 9-7-55. Unclassified.

A paper concerning problems of minimizing the maximum number of weighings and the expected number of weighings on a balance scale which may be required to cull out from a set of objects a subset of slightly heavier objects. 39 pp. Presented before the American Mathematical Society at Houston, Texas, December 27-29, 1955.

- **P-737. Recent trends in the Soviet economy.** J. A. Kershaw. 9-8-55. Unclassified.

A study of recent Soviet economic trends and their influence on USSR rates of growth. In addition, the rates in effect before Stalin's death and the influence of the post-Stalin changes are discussed, together with future economic developments. 26 pp. Illus. Published in *The Annals of the American Academy of Political and Social Science*, January, 1956.

- **P-738. A systematic approach to a class of problems in the theory of noise and other random phenomena.** D. A. Darling and A. J. F. Siegert. 9-10-55. Unclassified.

A problem of finding the probability of distribution of a certain functional where $X(\tau)$ is a (multi-dimensional) Markoff process and $\Phi(X, \tau)$ is a given function. A systematic approach to a wider class of problems is developed which contains as special cases most of the problems solved previously. 20 pp. See also P-730 and P-939. Published in the *IRE Transactions on Information Theory*, March, 1957.

- **P-739. Recent trends in Soviet trade.** Oleg Hoeffding. 9-15-55. Unclassified.

An attempt to determine whether the USSR has lately shown evidence of genuinely greater trade-mindedness than it displayed under Stalin. This study emphasizes Soviet trade with the West since 1953 and discusses briefly salient developments in bloc trade. 27 pp. Also published as RM-1567. Published in *The Annals of the American Academy of Political and Social Science*, January, 1956.

- **P-740. The background and implications of the Systems Research Laboratory studies.** J. L. Kennedy and R. L. Chapman. 9-21-55. Unclassified.

A discussion of the contribution of the Systems Research Laboratory in not only designing and operating complex man-machine systems, but also developing a theory of organizational behavior. 17 pp. Illus. Published in the *Symposium on Air Force Human Engineering, Personnel, and Training Research*, ed. by Glen Finch and Frank Cameron, Publication No. 455, National Academy of Sciences, National Research Council, Washington, D.C., 1956. \$4.00. Also published in *Air Force Human Engineering, Personnel, and Training Research*, Air Research and Development Command Technical Report 56-8, 1956. Presented before the National Research Council at Washington, D.C., November 14-15, 1955.

- **P-742. On differential games with survival payoffs.** Herbert Scarf. 9-22-55. Unclassified.

A proof that under certain conditions the upper and lower values of approximating games converge actually to the same function. A class of survival games in an arbitrary n -dimensional region R and with an arbitrary payoff function $f(x)$ on the boundary is considered. It is assumed that neither player can force the state of the game to proceed in any direction. 18 pp.

- **P-743. A simple algorithm for finding maximal network flows and an application to the Hitchcock problem.** L. R. Ford, Jr., and D. R. Fulkerson. 12-29-55. Unclassified.

A solution for finding a maximal flow and minimal cut in a transportation network in order to determine an efficient computational routine for the Hitchcock distribution problem. 22 pp. Illus. Also published as RM-1604. Published in the *Canadian Journal of Mathematics*, Vol. 9, No. 2, 1957. Presented before the Econometric Society at New York City, December 27, 1955.

P-744. Degrees of computability. N. Z. Shapiro. 10-3-55. Unclassified.

An investigation of the degrees of computability (in the theoretical sense) of certain decision problems and an extension of the Kleene hierarchy to partial relations. 38 pp. Published in the *Transactions of the American Mathematical Society*, July, 1956.

P-745. Maximum angular accuracy of a pulsed search radar. Peter Swerling. 4-10-56. Unclassified.

An investigation of the theoretical maximum accuracy with which the angular position of a target can be determined by a pulsed search radar. Operations performed on the received signal for estimating target angular position are discussed. In addition, the relation between the problem of target detection and that of estimating angular position is considered. 37 pp. Illus. Also published as RM-1491-1. Published in the *Proceedings of the Institute of Radio Engineers*, September, 1956.

• **P-746. A new approach to penetration mechanics.** J. H. Huth, J. S. Thompson, and M. E. Van Valkenburg. 10-6-55. Unclassified.

Results of experiments dealing with cratering in relatively thick targets in an attempt to evaluate the role of various physical parameters in high-speed impact phenomena. 27 pp. Illus. Published in the *Journal of Applied Mechanics*, March, 1957, under the title "Some New Data on High-speed Impact Phenomena." Presented at the Ninth International Congress of Applied Mechanics at Brussels, Belgium, September 5-13, 1956.

P-747-AEC. The Grüneisen parameter for an Einstein solid and under finite strain. J. J. Gilvarry. 9-26-55. Unclassified.

A study to determine the Grüneisen parameter (or constant), as evaluated from the equation of state, for an Einstein solid. A method is used which indicates the Einstein frequency in terms of elastic constants. 26 pp. Illus. Published in *The Physical Review*, April 15, 1956.

• **P-748. A fruitful application of static marginal analysis.** H. W. Karr and M. A. Geisler. 10-10-55. Unclassified.

An application of marginal analysis to the Air Force problem of designing mobility and war reserve packages of aircraft spares to be included in a package of given total size so that the number of shortages of parts will be minimized. In addition, examples of business problems to which this technique is applicable are presented. 23 pp. Illus. Published in *Management Science*, July, 1956.

P-749. The power spectrum of the turbulent-scattered field. W. C. Hoffman. 10-11-55. Unclassified.

A paper concerning the power spectrum of the turbulent-scattered field. 2 pp. Presented before a meeting of the Union Radio Scientifique Internationale at the University of Florida at Gainesville, December 7, 1955.

P-750. On reducing tension. Paul Kecskemeti. 10-10-55. Unclassified.

A discourse on (1) how the present international chronic tension compares with the transitory acute tensions before 1914 and (2) how chronic tension serves as an adjustment to a totally threatening situation. 13 pp. Published in *Commentary*, December, 1955.

P-753. Cogwheel: a film story of Systems Research Laboratory's activities. R. L. Chapman and M. G. Weiner. 9-21-55. Unclassified.

A discussion of *Cogwheel*, a sound film showing a 40-man Air Force crew operating an air-defense direction center in the RAND Systems Research Laboratory. This film describes the development of the *Cogwheel* crew as an organization, the complexities of direction-center operations, some problems of studying systems in a laboratory, and the realism in human behavior and environment building attained in such laboratory studies. 2 pp.

P-755. Notes on matrix theory—X: a problem in control. R. E. Bellman. 10-19-55. Unclassified.

A method for calculating $\int_0^\infty (x, Bx) dt$ without having to solve explicitly the differential equation $dx/dt = Ax$, $x(0) = c$. In addition, an equation due to Anke is generalized for an n th order linear differential equation. 4 pp. Published in the *Quarterly of Applied Mathematics*, January, 1957.

P-756. An introductory note for the proceedings of the Gainesville, Florida, Symposium on Monte Carlo Methods. A. W. Marshall. 10-24-55. Unclassified.

A discussion of (1) the progress of Monte Carlo techniques from 1949 to the present and (2) the papers presented before the Symposium on Monte Carlo Methods at Gainesville, Florida, March 16-17, 1954. Monte Carlo is defined as a random sampling procedure for treating mathematical problems of either deterministic or probabilistic type. 17 pp. Published in the *Symposium on Monte Carlo Methods*, ed. by H. A. Meyer, John Wiley & Sons, Inc., New York, 1956. \$7.50.

P-758 (out of print). Logistics and RAND: the first two years. Stephen Enke. 9-27-55. Unclassified.

A discourse on the RAND logistics program since its inception. This paper discusses the reasons why the work was undertaken, the staff and its assignments, and the difficulties not only in communicating ideas to the Air Force but also in implementing recommendations. 20 pp.

P-759. An automatic supervisor for the IBM 702. Bruse Moncreiff. 1-12-56. Unclassified.

A description of an automatic supervisory routine for the IBM 702 in an attempt to solve operating and programming problems characteristic of a situation in which the efficient day-by-day operation of the same routines is emphasized. 16 pp. Illus. Published in the *Proceedings of the Western Joint Computer Conference*, San Francisco, California, February 7, 1956. Presented before the Western Joint Computer Conference at San Francisco, California, February 7, 1956.

P-760. Use of an artificial satellite in upper air research. W. W. Kellogg and H. K. Kallmann. 2-15-56. Unclassified.

A study concerning the ability of a man-made satellite to explore the upper atmosphere. The major types of geophysically significant data obtainable are discussed, together with the uses of this information in solving certain atmospheric problems. In addition, the auxiliary requirements of attitude control, sensing devices, and telemetering are investigated. 9 pp. Illus. Published in the *Bulletin of the American Meteorological Society*, January, 1957. Presented before the American Meteorological Society at New York City, January 23, 1956.

P-761. Synoptic weather observations from extreme altitudes. S. M. Greenfield. 2-15-56. Unclassified.

An examination of the feasibility of analyzing systematically the data obtained from a vehicle capable of flying at extreme altitudes and of viewing a large area of the world over a relatively short time period. 12 pp. Illus. Presented before the American Meteorological Society at New York City, January 23, 1956.

P-763. Note on B. Klein's *Direct use of extremal principles in solving certain problems involving inequalities*. G. B. Dantzig. 1-29-57. Unclassified.

A discussion of B. Klein's proposal that ordinary methods of the differential calculus be used to minimize a function z of n variables x_1, x_2, \dots, x_n where the latter are subject to inequality restraints instead of usual equality restraints. The present paper considers whether this method may be constructively used for determining the optimum. 8 pp. Also published as RM-1864. Published in *The Journal of the Operations Research Society of America*, April, 1956.

• **P-764. Functional equations in the theory of dynamic programming—VI: a direct convergence proof.** R. E. Bellman. 11-8-55. Unclassified.

A paper dealing with the convergence of a discrete sum, independent of the continuous process. Convergence is established, using the functional equation technique of dynamic programming theory, under weaker conditions than those required by the classical calculus of variations. 18 pp. Published in the *Annals of Mathematics*, March, 1957.

P-765. Notes on control processes—I: on the minimum of maximum deviation. R. E. Bellman. 11-10-55. Unclassified.

An application of the functional equation technique of the dynamic programming theory to the problem of determining the minimum of the maximum deviation of a system from a preassigned state. 9 pp. Published in the *Quarterly of Applied Mathematics*, January, 1957.

P-766. Use of different Monte Carlo sampling techniques. Herman Kahn. 11-30-55.

Unclassified.

A discussion of designing and using such variance-reducing techniques in Monte Carlo problems as importance sampling, Russian roulette and splitting, use of expected values, correlation and regression, and systematic and stratified sampling. In addition, the author examines how these techniques may be applied to the Monte Carlo evaluation of definite integrals. 41 pp. Published in the *Proceedings of the Symposium on Monte Carlo Methods, Held at the University of Florida, March 16-17, 1954*, ed. by Herbert A. Meyer, John Wiley & Sons, Inc., New York, 1956. \$7.50. Presented before the Symposium on Monte Carlo at Gainesville, Florida, March 16-17, 1954.

- **P-767. Transient Markov chains with stationary measures.** T. E. Harris. 11-11-55.

Unclassified.

A presentation of conditions for the existence of nonnegative solutions Q_i of certain stationary equations where the quantities P_{ji} are the transition probabilities, from state j to state i , of a transient Markov chain. 11 pp. Published in the *Proceedings of the American Mathematical Society*, October, 1957.

P-768 (out of print). Politics of the Russian emigration. B. L. Dvinov. 10-1-55.

Unclassified.

A description of the political organizations of the Russian emigration since World War II. The author attempts to show how the Soviet émigrés might be effectively used in the interests of world democracy and how the situation for the individual émigrés involved might be improved. 440 pp. See also P-865 (out of print).

- **P-769. Climatology: complex, dynamic, and synoptic.** Arnold Court. 11-22-55. Unclassified.

A discussion of complex, dynamic, and synoptic climatology in an attempt to estimate the totality of weather, during a short time interval, as a unit. These branches of climatology have different uses arising from varying requirements and constitute several methods of analyzing meteorological observations. 28 pp. Published in the *Annals of the Association of American Geographers*, June, 1957.

P-770. On converses of Schwarz's inequality. R. E. Bellman. 11-22-55. Unclassified.

A general method for investigating problems involving the converse of the Schwarz and Hölder inequalities. 10 pp. Published in the *Duke Mathematical Journal*, September, 1956.

- **P-771. Notes on the theory of dynamic programming—VII: transportation models.** R. E. Bellman. 11-28-55. Unclassified.

Some applications of the functional equation technique of dynamic programming theory to a general class of problems arising in the study of networks, particularly those in transportation theory. 11 pp. Published in *Management Science*, January, 1958.

P-772. Limit theorems for noncommutative processes—II: on a generalization on the Stieltjes integral. R. E. Bellman. 11-28-55. Unclassified.

Some generalizations of the Riemann-Stieltjes integral arising from the study of positive definite matrices. 9 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series 2, Vol. V, 1956.

P-773. Notes on the theory of dynamic programming—VI: the warehousing model. R. E. Bellman. 11-29-55. Unclassified.

An attempt to determine how the functional equation technique of dynamic programming theory yields to a simple computational algorithm in order to solve mathematical models arising in stock level studies. 6 pp. Published in *Management Science*, April, 1956.

P-776-AEC. The equation of state of water on the Thomas-Fermi model. A. L. Latter and R. Latter. 10-24-55. Unclassified.

A description of two methods for extending the Thomas-Fermi model of a compressed atom to molecules containing two types of atoms. The methods are applied to H_2O at zero temperature in order to determine pressure and internal energy as functions of the density, the position of the protons relative to the oxygen nucleus, and the electrostatic potential distribution within the molecule. 25 pp. Illus. Published in *The Journal of Chemical Physics*, November, 1956.

P-777. On a generalization of the fundamental identity of Wald. R. E. Bellman.
1-23-56. Unclassified.

An extension of the fundamental identity of Wald in the theory of sequential analysis to the case where the variables are Markovian rather than independent. 7 pp. Published in the *Proceedings of the Cambridge Philosophical Society*, January, 1957.

P-778. A primal-dual algorithm. G. B. Dantzig, L. R. Ford, Jr., and D. R. Fulkerson.
5-9-56. Unclassified.

An extension of the Kuhn-Egerváry method for solving assignment problems in an attempt to apply to the general linear programming case a procedure for solving transportation problems. 16 pp. Illus. Also published as RM-1709. Published in *Annals of Mathematics Studies*, No. 38, 1956.

P-779. Prediction of political action by means of propaganda analysis. A. L. George.
12-22-55. Unclassified.

A study to determine an opponent's initiatives through analysis of his propaganda. This problem, which confronted the content analysts of the Federal Communications Commission during World War II, is investigated because of (1) the development of its methodological approach during World War II and (2) its theoretical interest in connection with the relationship of communication and action in the dealings between nations. 29 pp. Published in *The Public Opinion Quarterly*, Spring, 1956. Incorporated in *Propaganda Analysis*, Row, Peterson & Co., Evanston, Ill., 1959. \$6.00.

• **P-780. Dynamic programming and the numerical solution of variational problems.**
R. E. Bellman. 12-8-55. Unclassified.

The application of dynamic programming theory to the numerical solution of a large class of variational problems of the type occurring in a variety of applications. This paper attempts to present an applicable technique which can be used to compute the solution of numerous problems in a routine fashion, with no regard to linear or nonlinear, stochastic or deterministic features of the underlying processes. 23 pp. Illus. Published in *Operations Research*, April, 1957.

P-782. Optimal design and utilization of communication networks. R. E. Kalaba and
M. L. Juncosa. 7-13-56. Unclassified.

A mathematical treatment of general models representative of the users' requirements and of the capabilities and limitations of various communication systems. Several problems of designing and operating communication systems are reduced to problems in linear programming. In addition, optimal routing is considered. 25 pp. Illus. Also published as RM-1687. Published in *Management Science*, October, 1956. Presented before the joint meeting of The Institute of Management Sciences and the Operations Research Society of America at the University of California at Los Angeles, March 30, 1956.

• **P-783. An abstract setting for the notion of dynamic programming.** D. O. Ellis.
11-15-55. Unclassified.

A paper which discusses the axioms of a dynamic programming process and shows an appropriate version of optimal policy as a consequence. 12 pp.

P-784. Eigenvalues and functional equations. R. E. Bellman. 12-28-55. Unclassified.

A discussion of how the techniques of dynamic programming theory may be used to convert several eigenvalue problems into problems involving recurrence relations. It is assumed that only maximum or minimum values are considered. 8 pp. Published in the *Proceedings of the American Mathematical Society*, February, 1957.

P-785. The impact theory of the origin of lunar craters. J. J. Gilvarry and J. E. Hill.
1-4-56. Unclassified.

The results of computations on the pressures and temperatures attained in the impact of large meteorites on the lunar surface. These computations are based on the equation of state as obtained from the Thomas-Fermi statistical model of the atom. 9 pp. Illus. Published in the *Publications of the Astronomical Society of the Pacific*, June, 1956.

P-786. On Schlicht functions with real coefficients. Edgar Reich. 12-30-55. Unclassified.

A discussion of regular and Schlicht functions with real coefficients for $|z| < 1$. Functions of this type are associated with problems involving simple-connected regions that are symmetric in relation to a straight line or circle. 11 pp. Published in the *Duke Mathematical Journal*, September, 1956. Presented before a joint meeting of the American Mathematical Society and the Institute of Mathematical Statistics at Seattle, Washington, August 23, 1956.

● **P-787. Dynamic programming.** R. E. Bellman. 1-3-56. Unclassified.

A paper concerning dynamic programming theory and its applications. This theory is defined as a method of formulating functional equations which determine the optimal policies to make at each stage of the process in terms of the current situation. 4 pp. Published in the *Society for Industrial and Applied Mathematics Newsletter*, March, 1956.

P-788. The Soviet approach to international political communication. Paul Kecskemeti. 1-9-56. Unclassified.

A discourse on the political communications originating in Moscow and having the outside world as a target. The author attempts to isolate certain characteristics of this type of international communication that have remained relatively constant since Stalin's dictatorship was consolidated in spite of changes in the propaganda line. 25 pp. Published in *The Public Opinion Quarterly*, Spring, 1956.

P-789. Prices of basic industrial products in the USSR, 1928-1950. A. Bergson, R. Bernaut, and L. Turgeon. 1-12-56. Unclassified.

A paper concerning Soviet industrial price trends from 1928 to 1950. This is part of a broader investigation expected to derive index numbers for possible use in deflating some recently published current ruble national income data. 55 pp. Illus. See supplement RM-1919. Published in *The Journal of Political Economy*, August, 1956.

P-794. Weapon system cost analysis. David Novick. 1-24-56. Unclassified.

A summary of the methodology for computing Air Force weapon system costs used at RAND as of the winter of 1955. The methodology presented considers each factor entering into an Air Force weapon system, provides the demand measurements for economic resources, identifies the additional or incremental expenditures resulting from the use of a proposed new equipment, and distinguishes between the one-time or investment outlays and the recurring or annual operating expenses. 24 pp. Illus. Published in *IRE Transactions on Engineering Management*, July, 1956. Presented before the Institute of Radio Engineers at Los Angeles, California, January 18, 1956.

● **P-795. A simple model for the production of the normal electroencephalogram.** J. L. Kennedy and W. H. Emmons. 1-25-56. Unclassified.

A discussion of the hypothesis that normal brain waves result from physical oscillation of the gel of the living brain, driven by the mechanical action of the heart beat which is transmitted to the brain by the circulatory system. The results of a crucial experiment in support of this hypothesis are described. 12 pp. Illus. Presented before the American Psychological Association at Chicago, Illinois, September 4, 1956.

● **P-796. Dynamic programming and its application to variational problems in mathematical economics.** R. E. Bellman. 4-18-56. Unclassified.

A discussion of some variational problems arising from mathematical economics and some methods used to treat these questions both analytically and computationally. In particular, allocation and smoothing processes are examined in addition to the application of dynamic programming theory to these processes. 49 pp. Illus. Published in the *Proceedings of the Symposium in Calculus of Variations and Applications*, April, 1956.

P-797. Games with partial information. H. E. Scarf and L. S. Shapley. 4-13-56. Unclassified.

A discussion of a particular class of games with partial information in which each player is informed of his opponent's moves a fixed amount of time after they are made. In addition, some of the properties of games with perfect information are generalized to games with positive time lags. 27 pp. Published in the *Annals of Mathematics Studies*, No. 38, 1956.

- **P-798. A theorem on flows in networks.** David Gale. 6-22-56. Unclassified.

A proof of a generalization of a well-known combinational theorem of P. Hall. A set of origins (*A*) and destinations (*B*) are assumed to be connected by a network of finite capacity. A simple necessary and sufficient condition is given for the existence of a flow from *A* to *B* so that the flows into *B* shall attain prescribed values. 15 pp. Published in the *Pacific Journal of Mathematics*, Summer, 1957. Presented before the American Mathematical Society at New York City, April 20-21, 1956, and at Cambridge, Massachusetts, October 27, 1956.

- **P-799. The design of military supply tables for spare parts.** M. A. Geisler and H. W. Karr. 2-20-56. Unclassified.

A technique for designing supply tables of spare parts which differs from the usual military procedure. A supply table (i.e., a pre-assembled group of spare parts for use during a specified period without outside support) is sought which will minimize the expected number of shortages encountered during a given period of supply activity. 17 pp. Illus. Published in *Operations Research*, August, 1956.

- **P-801. Application of the Baldwin crater relation to the scaling of explosion craters.** J. E. Hill and J. J. Gilvarry. 1-27-56. Unclassified.

An attempt to predict the dimensions (diameter and depth) of a crater produced in the earth by detonation of a charge of high explosive situated on (or near) the surface. Two methods for scaling are developed. 30 pp. Illus. Published in the *Journal of Geophysical Research*, September, 1956.

- **P-802. A theory of organizational behavior deriving from Systems Research Laboratory studies.** R. L. Chapman. 3-12-56. Unclassified.

A paper which proposes an organizational behavior theory, based on a four-year experimental study of a particular man-machine system. This theory recognizes that system effectiveness can be predicted only if man's adaptive qualities are considered. 11 pp. Illus. Presented before the Western Psychological Association at Berkeley, California, March 29-31, 1956.

- **P-803. The value of airlift in defensive, local, or peripheral wars after 1960.** S. E. Eastman. 2-21-56. Unclassified.

A paper which discusses the value of airlift to the U.S. Air Force in a situation sometime after 1960 involving something less than the all-out general war. Military requirements for intercontinental air transportation are discussed, along with U.S. capacity to engage in limited war operations. 15 pp. Illus. Presented before the joint meeting of the Institute of the Aeronautical Sciences and the Society of Automotive Engineers, Inc., at Los Angeles, California, Spring, 1956.

- **P-804-AD. System training program.** 2-14-56. Unclassified.

A pamphlet introducing the System Training Program to members of an Aircraft Control and Warning crew. How the STP exercises help these crews practice defending the United States against enemy air attack is discussed. 11 pp. Illus.

- **P-807. On the application of the theory of dynamic programming to the study of control processes.** R. E. Bellman. 2-24-56. Unclassified.

A discussion of the application of the theory of dynamic programming to the study of some representative control processes of the type that arises in servomechanism theory and other parts of engineering analysis, electrical and mechanical. A general class of control problems is formulated, and numerous illustrative examples of both deterministic and stochastic types are presented, including the "bang-bang" control process. 21 pp. Published in the *Proceedings of the Symposium on Control Processes, Held at the Polytechnic Institute of Brooklyn*, April, 1956.

- **P-808. Economic development and the rate of interest under dictatorial conditions.** Harvey Leibenstein. 2-28-56. Unclassified.

An investigation of the importance of the interest rate in determining resource allocation under conditions of economic growth and dictatorially determined economic decisions (i.e., those made other than on the basis of consumers' sovereignty). The issues involved in this problem of allocation and dictatorial values are reviewed, together with the allocation criteria and the interest rate under both the aggrandizing and benevolent dictator. 27 pp. Formerly a part of RM-1342.

- **P-810. Evolution of computer codes for linear programming.** William Orchard-Hays. 3-14-56. Unclassified.

A discussion of the growth of computer codes for solving linear programming problems from the standpoint of mathematical and coding techniques. The current and proposed RAND developments in this field are presented. It is assumed that these codes are (1) adapted to the characteristics of the machine and for handling special requirements, (2) analogous to the method and not based on standard routines, and (3) capable of developing special techniques for special classes. 51 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

- **P-811. Nuclear weapons and changing strategic outlooks.** Bernard Brodie. 2-27-56. Unclassified.

A composite of two lectures, one presented before the Naval War College at Newport, Rhode Island, February 6, 1956, and the other before the Army War College at Carlisle Barracks, Pennsylvania, February 20, 1956. This paper examines the problems arising from the fact that no substitute for force in the government of international affairs has been discovered. 27 pp. Published in the *Bulletin of the Atomic Scientists*, February, 1957.

- **P-812. A note on the political role of mass meetings in a mass communications society.** W. P. Davison. 3-5-56. Unclassified.

A presentation of observations about the functions of political mass meetings. A by-product from a larger study of the Berlin blockade and airlift of 1948-1949, this paper suggests that political mass meetings offer a fertile field for study by political sociologists. 15 pp. Presented before the American Sociological Society at Detroit, Michigan, September 8, 1956.

- **P-813. The optimum distribution of lift in certain prismatic regions at supersonic speed.** W. W. Willmarth. 3-5-56. Unclassified.

A discussion of examples which satisfy Jones' criteria which identify the arrangements of lift, side force, and volume elements in a three-dimensional region that will have minimum drag when the total lift and volume are specified. 8 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, August, 1956.

- **P-815. Stalin and the uses of psychology.** R. C. Tucker. 3-1-56. Unclassified.

An investigation of certain Soviet ideological trends of recent years in their relation to the regime's policy in internal affairs. This study may serve as an aid in understanding some changes of interest in Soviet internal policy since Stalin's death. 63 pp. A condensed version of RM-1441. Published in *World Politics*, July, 1956.

- **P-818. Maintenance of a group of machines utilized intermittently and subject to several types of malfunctions—I: operational requirements and resource allocations.** W. P. Sewell. 4-19-56. Unclassified.

A paper which determines the preferred maintenance resource mixes in relation to the requirements of expected utilization rates and expected stand-by rates of a group of machines subject to several kinds of malfunctions requiring different repair resources. Several utilization scheduling policies are compared. 8 pp. Presented before the Operations Research Society of America at Washington, D.C., May 11, 1956.

- **P-819. Some queueing problems in machine maintenance.** D. S. Stoller. 9-12-56. Unclassified.

A discussion of the queueing problem for a group of machines in order to consider (1) machine utilization policies which set the activity level of those machines not requiring repairs as a function of the number of machines requiring repairs, and (2) maintenance scheduling policies which allocate resources to repairs in accordance with the number of machines requiring repairs of various types. 8 pp. Published in the *Naval Research Logistics Quarterly*, March, 1958. Presented before the Operations Research Society of America at Washington, D.C., May 9-10, 1956.

P-820. The relevance of costs in operations research. M. W. Hoag. 4-13-56. Unclassified.

A paper which divides operations research into studies in which (1) costs are largely irrelevant, (2) a measure of real cost internal to the analysis is required, and (3) real costs must be approximated by money costs. 18 pp. Illus. Published in *Operations Research*, August, 1956. Presented before the Operations Research Society of America at Washington, D.C., May 10, 1956.

P-821. On explicit solutions of some trinomial equations in terms of the maximum operation. R. E. Bellman. 3-14-56. Unclassified.

A discussion of the nonnegative solutions of certain trinomial equations. It is shown that the unique positive root of such equations can be exhibited in explicit form, provided that the operation of taking the maximum or minimum of a function is allowed. 6 pp. Published in *Mathematics Magazine*, September-October, 1956.

P-822-AEC. Close-in fallout. W. W. Kellogg, R. R. Rapp, and S. M. Greenfield. 3-12-56. Unclassified.

A summary of research concerned with all aspects of the transport, dispersal, and fallout of atomic debris from nuclear explosions. Methods are discussed for making a quantitative study of the manner in which close-in fallout occurs. 24 pp. Illus. See R-309. Published in the *Journal of Meteorology*, February, 1957.

P-823. Weapon-system cost analysis. G. H. Fisher. 7-10-56. Unclassified.

A method for estimating cost inputs for weapon-systems analyses and a discussion of the characteristics of this method. In addition, its use as a tool in Air Force planning and programming of future weapons systems is examined. 20 pp. Illus. Published in *The Journal of the Operations Research Society of America*, October, 1956.

P-824. Thoughts on linear programming and automation. G. B. Dantzig. 3-2-56. Unclassified.

A review of developments in linear programming, its application to the petroleum industry, and its relation to automation. This paper attempts to determine whether the mechanization of the more complex control processes is the beginning of superautomation. 16 pp. Illus. Published in *Management Science*, January, 1957. Presented before the faculty colloquium at the University of California at Berkeley, March 2, 1956.

P-825. United States policies on disarmament, 1946-1955: a critique. H. A. De Weerd. 3-22-56. Unclassified.

A discourse on establishing a system of international control of nuclear weapons and on the basic unreliability of any foreseeable inspection system. The major U.S. proposals on nuclear disarmament and limitations since 1945 are reviewed, together with the causes for the failure of these proposals. 20 pp. Published as "Disarmament Failure and Limitation" in *Army*, February, 1957. Presented before a joint meeting of the Minnesota World Affairs Center and the Woodrow Wilson Foundation at Minneapolis, Minnesota, May 10, 1956.

P-826. On the max flow min cut theorem of networks. G. B. Dantzig and D. R. Fulkerson. 4-15-55. Unclassified.

A discussion of a problem related to the study of transportation networks. It is shown that Menger's theorem and the Max Flow Min Cut Theorem on networks are applications of the duality theorem of linear inequality theory. 12 pp. Also published as RM-1418-1. Published in *Annals of Mathematics Studies*, No. 38, 1956.

- **P-827. A primal-dual algorithm for the capacitated Hitchcock problem.** L. R. Ford, Jr., and D. R. Fulkerson. 9-25-56. Unclassified.

An attempt to show how the Hitchcock problem with capacity constraints on routes may be handled by using the flow algorithm for the restricted primal. The computation proposed is extremely efficient because of the simplicity of the flow algorithm for the restricted primal and the fewer iterations required by the primal-dual method. 13 pp. Illus. Also published as RM-1798. Published in the *Naval Research Logistics Quarterly*, March, 1957. Presented before the RAND Linear Programming Conference at Santa Monica, California, August 31, 1956.

P-829. Surface-protection and cooling systems for high-speed flight. C. Gazley, Jr., and D. J. Masson. 4-16-56. Unclassified.

A discussion of systems for surface protection against transient and continuous heat inputs, corresponding to typical missile and aircraft flight paths. Comparisons of various systems are made for several typical operating conditions. 40 pp. Illus. Also published as RM-1735. Published in the *Aeronautical Engineering Review*, November, 1956. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, June 18, 1956.

P-832. The nature of axisymmetric wave fields in elastic solids. H. A. Lang. 11-2-56. Unclassified.

An attempt to determine the displacements and stresses established in an infinite half-space by a concentrated unit impulse which is a step function of time. The procedure of F. Sauter, previously applied to the concentrated line shock in two dimensions, is extended to the axially symmetric case. 39 pp. Illus. See also P-1141 and P-1173. Presented before the Ninth International Congress of Applied Mechanics at Brussels, Belgium, September 12, 1956, and before the Applied Mechanics Division of the American Society of Mechanical Engineers at New York City, December 3, 1957.

P-833. The moon rocket. G. H. Clement. 5-7-56. Unclassified.

A paper concerned with designing a rocket vehicle to reach the moon and establishing the performance requirements for such an earth satellite. 19 pp. Illus. Published in the *Proceedings of the Symposium, Held April 18, 1956, at the Franklin Institute in Philadelphia—Monograph No. 2*, June, 1956. \$2.50. Presented before the Franklin Institute at Philadelphia, Pennsylvania, April 18, 1956.

• **P-834. Application of dynamic programming to the airplane minimum time-to-climb problem.** T. F. Cartaino and S. E. Dreyfus. 1-18-57. Unclassified.

An application of the dynamic programming technique to the solution of the airplane minimum time-to-climb problem. A typical case is solved. 19 pp. Illus. Also published as RM-1710. Published in the *Aeronautical Engineering Review*, June, 1957, and in the *Proceedings of the Symposium on Digital Computing in the Aircraft Industry*, January 31–February 1, 1957. Presented before the Symposium on Digital Computing in the Aircraft Industry at New York City, January 31, 1957.

P-835. Physical properties of the atmosphere from 90 to 300 kilometers. H. K. Kallmann, W. B. White, and H. E. Newell, Jr. February 1956. Unclassified.

A presentation of an average model atmosphere for the region between 90 and 300 km. It is assumed that (1) molecular oxygen begins to dissociate appreciably only above 90 km, (2) at around 130 km about 30 per cent of O_2 is still in the undissociated state, (3) molecular nitrogen begins to dissociate above 220 km, (4) the concentration of molecular oxygen and nitrogen decreases with altitude exponentially, and (5) the temperature becomes isothermal in the region of the exosphere. 27 pp. Illus. Prepared for the group working on the extension of the U.S. Standard Atmosphere. Published in the *Journal of Geophysical Research*, September, 1956.

P-836. The impact of large meteorites. J. J. Gilvarry and J. E. Hill. 4-3-56. Unclassified.

An examination of the impact of large meteorites on the moon or earth. This study is based on a one-dimensional idealization of the flow problem, in which a plane shock wave in both meteorite and impact surface is considered. Conditions are discussed under which a model can yield physically valid estimates of pressure and temperature generated on explosive impact of meteorites. 24 pp. Illus. Published in *The Astrophysical Journal*, November, 1956.

• **P-837. Multidimensional maximization, dynamic programming, and economic lot size.** R. E. Bellman. 4-3-56. Unclassified.

A proof that some economic lot size problems lead to the analytic problem of obtaining the maximum of a certain function, subject to numerous constraints of a specific form. This paper attempts to determine a sequence of functions by the functional equation approach of dynamic programming theory. 20 pp.

P-838. Lecture notes on the effects of neutron irradiation on reactor fuel composition and reactivity. George Safonov. 2-22-56. Unclassified.

A discussion of the transmutation chains of nuclear fuel, the effects of irradiation on reactor reactivity, and the feed costs for U^{235} and U^{238} burners. 26 pp. Illus. Presented before the Engineering Department of the University of California at Los Angeles, February 23, 1956, and before the Engineering Department of the University of California at Berkeley, March 14, 1956.

P-839. On the principle of invariant imbedding and propagation through inhomogeneous media. R. E. Bellman and R. E. Kalaba. 4-10-56. Unclassified.

A technique for studying propagation through inhomogeneous and random media, based upon an invariance principle. The problem of the scattering of light by an inhomogeneous plane medium of finite thickness is considered. The corresponding problem for homogeneous media has been treated by Ambarzumian and Chandrasekhar. 8 pp. See also P-976, P-996, P-1102, P-1252, P-1380, P-1390, P-1495, and T-63. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September, 1956.

P-840. Properties of the shock transition at low temperature. J. J. Gilvarry. 4-12-56. Unclassified.

A study which shows Bethe's equation for the change of entropy in waves of finite amplitude to be inapplicable for an initial state of temperature arbitrarily close to absolute zero for a substance possessing a zero-point pressure (or energy). Thermodynamic functions for such a substance at low temperature are formulated in terms applicable to the Fermi-Dirac gas, the Thomas-Fermi atom, the Debye solid, and the Mie-Grüneisen solid as special cases. In addition, the conditions are presented under which the equation of state satisfies the Bethe-Weyl conditions. 15 pp. Published in the *Journal of Applied Physics*, December, 1956.

P-841. Strategy versus tactics in a nuclear age. Bernard Brodie. 4-16-56. Unclassified.

A discourse on the roles of strategy and tactics in a world that possesses both thermonuclear weapons and the experience of almost unlimited war. The author states that the defense problem is more likely to be solved by strategy and national policy than by tactics. 26 pp. Incorporated in R-335. Published in *Brassey's Annual: The Armed Forces Yearbook*, ed. by H. G. Thursfield, C. N. Barclay, and W. M. Yool, The Macmillan Co., New York, 1956. \$9.50. Incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, N.J., 1959. \$6.50. Presented before the Graduate Institute of International Studies at Geneva, Switzerland, May 28, 1956.

P-842. Manual for the RAND-IBM code for linear programming on the 704. W. Orchard-Hays, L. Cutler, and H. Judd. 5-16-56. Unclassified.

A presentation of a linear programming system which is the modified simplex procedure with the product form of inverse. It is designed to solve the classical linear inequalities problem and most of its variations on the IBM 704. 50 pp. Copies of this manual were distributed by IBM (in New York) to the SHARE Organization for 704 users.

P-843-RC. Censorship in the USSR: a documented record. Merle Fainsod. 2-15-56. Unclassified.

A discourse on the verity of a leading Soviet journalist's statement (printed in the *U.S. News and World Report* on November 11, 1955) that Soviet press censorship was abolished after World War II. The contents of some documents available in the West which concern the work of the Soviet censorship apparatus and the problems Soviet censors encounter are discussed. 29 pp. Published in *Problems of Communism*, March-April, 1956.

P-844. Optimal utilization and extension of interoffice trunking facilities. R. E. Kalaba and M. L. Juncosa. 11-15-56. Unclassified.

An illustration of the use of linear programming in several interoffice trunking problems relating to the optimal utilization of existing plant facilities and to the minimal cost design of additional facilities. Problems of both types and methods for solving them are presented. 21 pp. Published in *Communication and Electronics*, January, 1959. Presented before the American Institute of Electrical Engineers at New York City, January 21-25, 1957.

P-845. Notes on the theory of dynamic programming—VIII. R. E. Bellman. 4-18-56. Unclassified.

A treatment of a problem that minimizes a certain linear form subject to constraints of a specific type. This problem, arising from the production smoothing problem, is solved by dynamic programming methods. 5 pp. Published in *Management Science*, October, 1956.

- **P-846. Priority assignment on a waiting line.** S. A. Dressin and E. Reich. 4-19-56. Unclassified.

A paper dealing with communications applications which discusses queueing statistics when a priority system is involved. A model is described in the usual customer-counter terminology. 7 pp. Published in the *Quarterly of Applied Mathematics*, July, 1957. Presented before the Operations Research Society of America at Washington, D.C., May 11, 1956.

P-847. Administration of research in a research corporation. J. L. Kennedy and G. H. Putt. 4-20-56. Unclassified.

A description of some organizational problems of the new research corporation from the viewpoint of a research administrator and a researcher. A tool for improving communication between researcher and administrator is discussed, together with its use in planning a large-scale research program. 21 pp. Published in the *Administrative Science Quarterly*, December, 1956.

- **P-848-RC. The search for decision in national defense.** F. M. Sallagar. 10-15-55. Unclassified.

Two lectures delivered before the Harvard Defense Policy Seminar at Cambridge, Massachusetts, November 23, 1954, and March 15, 1955. The process by which decisions on national policy issues are made is discussed. In addition, subjects ranging from the Wilsonian vision of the world to the housekeeping problem of the services are considered in an attempt to determine the factors responsible for this search for decision. 66 pp.

P-849-AEC. Calculation of fields on plasma ions by collective coordinates. A. A. Broyles. 4-24-56. Unclassified.

Computations, with the aid of collective coordinates, on the probability of finding a given electric field on an ion in a plasma. All the ions are assumed to have the same charge, and the free electrons are replaced by a rigid negative smear. The Jacobian of the transformation to collective coordinates is expanded in a series of Hermite polynomials, and one of the higher terms is computed as an estimate of the error. 33 pp. Illus. Published in *The Physical Review*, January 15, 1957.

P-850. Current developments in complex information processing. A. Newell and H. A. Simon. 5-1-56. Unclassified.

A study of complex information processing, defined by a series of tasks requiring complicated feedbacks and rules of operation. The role of computers in understanding such processes is emphasized, and current efforts on these problems are discussed. 38 pp. Presented before the Conference on Computers and Automation at Washington, D.C., May 2, 1956.

P-851. Political behavior in a crisis: some observations from the Berlin blockade. W. P. Davison. 4-30-56. Unclassified.

A study of the mass attitudes and political behavior during the Berlin blockade which commenced on June 24, 1948, when the Soviets announced that all overland traffic between Berlin and West Germany was stopped. The stages through which the Berliners passed before they decided on the course to follow are reviewed, together with the events during this period. 22 pp. Published as "Political Significance of Recognition via Mass Media—An Illustration from the Berlin Blockade" in *The Public Opinion Quarterly*, Spring, 1956. Presented before the American Association for Public Opinion Research at Buckhill Falls, Pennsylvania, May 25, 1956.

- **P-852. The steady, axially symmetric flow of a viscous fluid in a deep rotating cylinder which is heated from below.** G. N. Lance and E. C. DeLand. 11-20-56. Unclassified.

An extension of the theory of T. V. Davies for solving differential equations for the dishpan experiments. Results are shown for the cases of three depths of fluid and, for each depth, curves are drawn for varying values of the rotation Reynolds number R . Considered a preliminary to a

theoretical treatment of Hide's experiments, the present work is similar to the meteorological problem dealing with the general circulation of the atmosphere. 29 pp. Illus. Presented before the Symposium on Heat Transfer at the University of California at Los Angeles, August 15, 1955.

P-853. Soviet atomic policy. M. J. Ruggles and A. Kramish. 5-23-56. Unclassified.

A study showing the range and direction of USSR nuclear research since the mid-1930's. The rapid strides of the Soviets in military and nonmilitary applications of atomic energy are discussed, together with related aspects of their foreign policy. It is suggested that further research on Russian atomic policy by the U.S. should prevent such technological and political surprises as those which have occurred in the past. 14 pp. See also RM-1711, RM-1896, and RM-2163. A *Time* magazine story of July 30, 1956, was based on this paper.

P-854. Amplitudes of thermal vibration at fusion. J. J. Gilvarry. 5-1-56. Unclassified.

An attempt to determine relatively accurate values of the Lindemann constant for ten metals by using rigidity moduli at fusion with previously estimated bulk moduli. This study is based on the Debye-Waller theory of the thermal dependence of X-ray reflection intensity. Agreement of the derived value ρ of the critical ratio of root-mean-square amplitude of thermal vibration to nearest-neighbor distance at fusion, with the corresponding value from X-ray intensity data, is improved for the one case (Al) favorable for comparison. 16 pp. Table. Also published as RM-1704. Published in *The Physical Review*, September, 1956.

P-855. Air Force logistics: some recent developments. A. R. Ferguson. 5-3-56. Unclassified.

A study of the developments in Air Force logistics designed to make the system capable of performing its functions in the military environment in the early 1960's. Such aspects are discussed as the introduction of improved logistics policies, the role of airlift, and the maintenance of control over Air Force assets. 19 pp. Illus. See revised version RM-1817. Published in the *Aeronautical Engineering Review*, January, 1957. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, June 19, 1956.

P-856. Best exploration for maximum is Fibonaccian. S. M. Johnson. 5-4-56. Unclassified.

A discussion of a unimodal function of one variable, defined on an interval. The author attempts to minimize the number of calculations of values of the function in order to ensure the location of its maximum to a prescribed degree of accuracy. The solution of this problem and its discrete analogue involve the Fibonacci sequence. 8 pp. A revision of RM-1590. Presented before the Econometric Society at Seattle, Washington, August 23, 1956.

P-857-AD. PACT-1A. T. B. Steel, Jr. 5-25-56. Unclassified.

A discussion of the creation of the PACT-1A language and the coding of a compiler for the 704 electronic data processing machine. The compilation technique used, as in PACT-1, is a sequential processing of tapes, going through sufficient passes to complete the compilation. 4 pp. Published in the *Journal of the Association for Computing Machinery*, January, 1957.

P-859. Functional equations in the theory of dynamic programming—VII: an integro-differential equation for the Fredholm resolvent. R. E. Bellman. 5-7-56. Unclassified.

An attempt to determine an integro-differential equation (using dynamic programming theory) for the Fredholm resolvent of the linear integral equation. Under appropriate conditions, the Fredholm equation may be considered as the extremal equation for a specific quadratic functional. 9 pp. Published in the *Proceedings of the American Mathematical Society*, June, 1957.

• **P-860. RAND research on a data-processing system for the United States Air Force.** M. A. Geisler. 5-7-56. Unclassified.

A description of RAND research on a logistics data-processing system and the status of its development. This system, designed to meet Air Force needs in the 1960's, will greatly determine not only the cost of logistics support but also the extent to which the Air Force can operate under difficult conditions. 13 pp. Presented before a Conference on Automatic Data-processing Systems at Washington, D.C., April 10, 1956.

P-861. Information in games with finite resources. David Gale. 5-7-56. Unclassified.
A proof that, in games with finite resources, the uniform mixed strategy is optimal. Therefore, a player is not helped by knowing the strategies available to his opponent. 9 pp. Also published as RM-1542. Published in *Annals of Mathematics Studies*, No. 39, 1958.

P-863. Birth-death processes and tandem queues. Edgar Reich. 6-22-56. Unclassified.
A discussion of a simple property of stationary birth and death processes, which implies that for certain queues, the output process is closely related to the input process. This theorem is applied to a situation where customers proceed to a second queue after having been processed at a first queue. 5 pp. Published as "Waiting Times When Queues Are in Tandem" in *The Annals of Mathematical Statistics*, September, 1957.

P-865 (out of print). Documents on the Russian emigration: an appendix to RAND Paper P-768. B. L. Dvinov. 5-11-56. Unclassified.

An appendix to P-768, *Politics of the Russian Emigration* (out of print). The present paper contains the texts, in translation, of several documents dealing with the political activities of the Russian emigration. 231 pp.

P-866. On a dynamic programming approach to the caterer problem—I. R. E. Bellman. 5-17-56. Unclassified.

A proof that the caterer problem can be reduced to the problem of determining the maximum of a certain linear form, subject to a series of constraints of a specific form. The nonaccumulation of dirty laundry is assumed. This maximization problem is solved explicitly, using the functional equation technique of dynamic programming. 18 pp. Published in *Management Science*, April, 1957.

P-868. The logic theory machine: a complex information processing system. A. Newell and H. A. Simon. 7-12-56. Unclassified.

A description of a computer program for a logic theory machine, which proves theorems in the propositional calculus. This machine is programmed to solve problems in a manner similar to that of human beings, as the simulation extends to the level of basic information processes. 63 pp. Published in the *IRE Transactions on Information Theory*, September, 1956. Presented before the Professional Group on Information Theory of the Institute of Radio Engineers at Cambridge, Massachusetts, September 10, 1956.

P-869. Dynamic programming and Lagrange multipliers. R. E. Bellman. 5-21-56. Unclassified.

A proof that a combination of the classical Lagrange multiplier formalism and the functional equation technique of dynamic programming provides a basis for dealing with numerous types of specific variational problems. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, October, 1956.

P-870. Professor Koopmans on fallacies: a comment. C. J. Hitch. 5-21-56. Unclassified.

Remarks on Professor Koopmans' views concerning fallacies in operations research. The need of some reoriented thinking about the development of operations research (OR) is emphasized, and the choice of criteria is suggested as an important factor in improving the OR product. 8 pp. Published in *Operations Research*, August, 1956. Presented before the Operations Research Society of America at Washington, D.C., May 10, 1956.

P-871. Beryllium as an aircraft structural material. G. A. Hoffman. 5-28-56. Unclassified.

A review of RAND work on beryllium. Structural evaluation, economic considerations, and a hypothetical example are discussed, together with suggestions for research. 30 pp. Illus. Published in the *Aeronautical Engineering Review*, February, 1957; in *Aviation Week*, December 17, 1956; in *Materials and Methods*, February, 1957; in *Western Aviation*, December, 1956; and in *Western Metals*, December, 1956. Presented before the Solid Mechanics Seminar at the California Institute of Technology, Pasadena, California, March 5, 1957, and before the Specialist Meeting of the Institute of the Aeronautical Sciences at New York City, November 12, 1956.

P-872-AEC. Photoelectric K and L shell absorption coefficients for highly ionized atoms. S. A. Moszkowski and R. E. Meyerott. 5-29-56. Unclassified.

A study of the absorption coefficients averaged over subshells for the K and L shells of atoms and ions. The absorption coefficient is expressed in terms of an effective charge which is evaluated with the use of coefficients given by R. E. Meyerott. The effective charge is also expressed in terms of an effective screening constant useful in certain limiting cases. A comparison is made between the various methods of computation, and their reliability is discussed. 9 pp. Tables. Published in *The Astrophysical Journal*, November, 1956.

Ø **P-873. Artificial satellites of the moon.** R. W. Buchheim. 6-14-56. Unclassified.
A discussion of the requirements for establishing an artificial satellite of the moon. Such problems are considered as general orbit properties, limiting orbit parameters, transporting the satellite to the moon, and its visibility on orbit. 69 pp. Illus. Also published as RM-1941. Presented before the International Astronautical Congress at Rome, Italy, September 19, 1956.

P-875. Temperatures in the earth's interior. J. J. Gilvarry. 6-6-56. Unclassified.

An evaluation of fusion temperatures for the earth's mantle from Lindemann's law, by the use of elastic parameters determined for a given depth from seismic data. By using data on the temperature in the earth at small depth and using limits imposed on the possible value by melting temperatures at large depth, the actual temperature in the earth is represented approximately by a quartic polynomial in the depth. 22 pp. Illus.

P-876. Discrete variable extremum problems. G. B. Dantzig. 12-12-56. Unclassified.

Data on the use of linear programming methods to solve discrete variable extremum problems. In addition, an example of the use of the multistage approach of dynamic programming is discussed. 23 pp. Illus. Also published as RM-1832. Published in *Operations Research*, April, 1957.

● **P-877. Solution of a ranking problem from binary comparisons.** L. R. Ford, Jr. 6-7-56. Unclassified.

A method for solving a ranking problem from binary comparisons which does not require any specific number of comparisons between pairs. This procedure may be applied to such problems as ranking (1) various makes of automobiles and (2) players of a two-person game on the basis of their records against each other. 14 pp. Also published as RM-1860. Presented before a joint meeting of the American Mathematical Society and the Institute of Mathematical Statistics at Seattle, Washington, August 23, 1956.

● **P-878-RC. The *règle du jeu* of the French parliament: as exemplified in the election of President Coty.** N. C. Leites and C. Melnik. 6-22-56. Unclassified.

Part of a broader investigation concerned with the spirit of contemporary French politics. The joint session of the French parliament, held from December 17 to 23, 1953, at which René Coty was elected President of the Republic, is discussed in an attempt to determine the impact of the predictions of electoral success and the failure of these predictions on the actual voting. 21 pp. Presented before the American Political Science Association at Washington, D.C., September 7, 1956.

P-879-RC. The nationalization of research and development in the U.S. J. C. DeHaven. 1-21-57. Unclassified.

A discussion of the "shortage" of engineers and scientists and of the steps which may be taken to alleviate the situation. A hypothesis is presented which suggests that contracting and contract administration practices have evolved which distort the demand and impose price control for these professional talents in government and government-contracted work. 23 pp. Illus. Published in *Pacific Electronics Monthly*, March, 1957; in *Aviation Age*, July, 1957; and in *Chemical Engineering Progress*, October, 1957. Presented before the American Society for Engineering Education at Ames, Iowa, June 29, 1956, and before the Institute of Radio Engineers, Professional Group on Electronic Computers, at Los Angeles, California, January 15, 1957.

● **P-880. Weapons system philosophy.** G. H. Clement. 7-27-56. Unclassified.

A discourse on the concept of systems analysis as employed in the development of military equipment. A general discussion of systems analysis philosophy is followed by a particular application

to air defense weapons. 19 pp. Presented before the Advisory Group for Aeronautical Research and Development Seminar on Guidance and Control of Guided Missiles at Venice, Italy, September 24-27, 1956.

P-881-AEC. Atomic cloud height as a function of yield and meteorology. W. W. Kellogg. 6-14-56. Unclassified.

A study dealing with the height of burst and the yield of a nuclear device, the development and rise of the fireball into a toroidal cloud, and its subsequent fallout. It is shown how the atmospheric stability affects the height to which the cloud rises, and the shape it acquires when its ceiling is reached. 15 pp. Illus. See R-309. Presented before the American Meteorological Society at Albuquerque, New Mexico, September 6, 1956.

P-882-AEC. A mathematical model of the phenomenon of radioactive fallout. R. R. Rapp. 6-15-56. Unclassified.

A study of the transport and deposition of radioactive debris from a nuclear detonation. The author describes (1) the influence of the distribution of activity in space and with particle size, (2) the nature of the falling velocities of particles as a function of size and height, (3) the role of the various scales of motion of the atmosphere in transporting and dispersing the radioactive debris, and (4) a mathematical model of the essential elements of the fallout problem, together with some sample calculations. 14 pp. Illus. See R-309. Presented before the American Meteorological Society at Albuquerque, New Mexico, September 6, 1956.

P-883-AEC. Rain scavenging of radioactive particulate matter from the atmosphere. S. M. Greenfield. 7-16-56. Unclassified.

The derivation of a physical model to explain the removal of radioactive particulate matter from the atmosphere by rain. The processes considered quantitatively are (1) direct pickup of radioactive particles by rain and (2) scavenging by raindrops of cloud droplets which have already collected the smaller radioactive particles. 29 pp. Illus. See R-309. Published in the *Journal of Meteorology*, April, 1957. Presented before the American Meteorological Society at Albuquerque, New Mexico, September 6, 1956.

P-884. Elastic stresses produced in a half plane by steadily moving loads. J. D. Cole and J. H. Huth. 6-21-56. Unclassified.

A study concerned with the uniform motion of a concentrated line-load along the surface of an elastic half plane. The resulting stresses and displacements can be used in estimating the effects of a surface pressure wave. In particular, the problem (plane strain) is mathematically formulated and solved for all speeds. 20 pp. Illus. See also RM-1762. Published in the *Journal of Applied Mechanics*, December, 1958. Presented before the Ninth International Congress of Applied Mechanics at Brussels, Belgium, September 5-13, 1956.

● **P-885. A comparison of linear programming and dynamic programming.** S. E. Dreyfus. 6-22-56. Unclassified.

A discussion of the applications and interrelations of linear and dynamic programming. An attempt is made to place each in a proper perspective so that the two techniques may be efficiently used. 15 pp.

● **P-886. Policy objectives and military action in the Korean war.** W. W. Kaufmann. 6-26-56. Unclassified.

A discussion of the Korean conflict as an example of the difficulty of controlling and limiting warfare. The grievances of the military on the constraints placed upon military operations and on the failure of civilian authority to support military leadership at that time are examined. 34 pp. Presented before the American Political Science Association at Washington, D.C., September 7, 1956.

● **P-887. Detailed analysis of synoptic weather as observed from photographs taken on two rocket flights over White Sands, New Mexico, July 26, 1948.** J. A. B. Bjerknes. 4-1-51. Unclassified.

An appendix to R-218, *Inquiry into the Feasibility of Weather Reconnaissance from a Satellite Vehicle*. Cloud formations observed from photographs taken over White Sands, New Mexico, July 26, 1948, are analyzed. 18 pp. Illus.

P-888. A solution containing an arbitrary closed component. L. S. Shapley. 7-3-56.

Unclassified.

A discussion of an n -person game solution constructed around an arbitrary closed set. It is shown that there is practically no limit to the possible complexity of solutions. 10 pp. Illus. Also published as RM-1005. Published in the *Annals of Mathematics Studies*, No. 40, 1959.

• **P-889. Comments on warfare in the next ten to twenty years.** N. C. Peterson. 6-19-56.

Unclassified.

A discourse on (1) the environment and probability of various kinds of conflicts in the next ten to twenty years, and (2) the desirable directions of development, in the broadest sense, of U.S. military forces and foreign policy during this period. 15 pp. See also P-1085. Presented before the Technical Advisory Group and some of the staff of the Air Force Armament Center at Valparaiso, Florida, May 24, 1956.

• **P-890. Hitchcock transportation problem.** D. R. Fulkerson. 7-9-56. Unclassified.

An exposition of the simplex computation for transportation-type problems. The optimal assignment problem, upper bounds on variables, and the transshipment problem are discussed in connection with the solution of the Hitchcock problem. 29 pp. Illus. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

• **P-891. The simplex method.** G. B. Dantzig. 7-9-56. Unclassified.

A discussion of the simplex method, for solving a linear program, which first transforms the original system to an equivalent system of m equations in canonical form by eliminating m of the n unknowns. If the right choice of m variables is made, an optimal solution is obtained to the original problem by equating the remaining variables to zero. If not, the method produces an improved set of m variables and a corresponding canonical form. The procedure is iterated until an optimum solution is determined. 31 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

• **P-892. The central mathematical problem.** G. B. Dantzig. 7-9-56. Unclassified.

An analysis of the central mathematical problem of linear programming, defined as the minimization of a linear form subject to linear inequality restraints. This paper discusses (1) the linear programming model stated in algebraic terms, (2) equivalent systems, (3) properties of solutions and the simplex method, (4) existence of solutions (uniqueness), and (5) numerous other problems. 19 pp. Illus. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

• **P-893. Formulating a linear programming model.** G. B. Dantzig. 7-9-56. Unclassified.

A discussion of linear programming as a technique for building a model to describe the interrelations of the components of a system. The relationship between the activities and items of the system constitutes the linear programming model and gives rise to the central mathematical problem. A simplified oil refinery example is used to illustrate the principles of building such a model. 11 pp. Illus. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-894. Variation of the amplitude of thermal vibration on the fusion curve. J. J. Gilvarry. 7-11-56. Unclassified.

A generalization of a differential relation equivalent to the Debye-Waller identification of the Debye and Lindemann frequencies at fusion. An attempt is made to determine the variation along the fusion curve of the critical ratio of the root-mean-square amplitude of thermal vibration to the nearest-neighbor distance of the atoms in the solid at fusion. This theory yields an expression for the Grüneisen parameter of a solid at fusion in terms of (1) fusion parameters and (2) the rate of change of the critical ratio with respect to volume. 21 pp. Tables. Published in *The Physical Review*, November, 1956.

P-895. Solving the transportation problem. L. R. Ford, Jr., and D. R. Fulkerson. 7-17-56. Unclassified.

A paper which describes a new computing procedure for the Hitchcock-Koopmans transportation problem and gives a step-by-step solution of an illustrative example. The procedure is based on Kuhn's combinatorial algorithm for the assignment problem and a simple labeling process for solving

maximal flow problems in networks. 17 pp. Illus. Also published as RM-1736. Published in *Management Science*, October, 1956.

P-896. Disarmament failure and weapons limitations. H. A. De Weerd. 7-16-56. Unclassified.

A paper which discusses the major American proposals on nuclear disarmament and limitation since 1946 and the causes for the failure of these proposals. In addition, the potentiality of the policy of limiting the use of nuclear weapons is discussed. 20 pp. Published as "The Case for Weapons Limitation" in *Army*, February, 1957.

P-897. Atmospheric transmission. S. Passman and L. Larmore. 7-11-56. Unclassified.

A study which presents (1) the values of the water vapor error function absorption coefficients, β , for infrared radiation in the wavelength region from 1.4 microns to 5.9 microns, and (2) the resultant actual transmission values as a function of wavelength in the 1.4 to 5.9 micron region to 0.1μ intervals. 7 pp. Tables. Published in the *Proceedings of Infrared Information Symposium*, March, 1957.

● **P-898. The response of a bisymmetric aircraft to small combined pitch, yaw, and roll control actions.** R. A. Davis. 12-27-56. Unclassified.

A formulation (by the use of body axes) of the linearized equations of motion of a rolling bisymmetric aircraft. The complete solution to the equations is presented for a stepped pitch-yaw control action at constant roll rates and for a variable roll rate. 23 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, December, 1957. Presented before the Institute of the Aeronautical Sciences at New York City, January 28-31, 1957.

P-899. War gaming as a technique of analysis. A. M. Mood. 9-3-54. Unclassified.

A discussion of war gaming techniques, devised to deal with problems whose analysis requires appreciable context. 13 pp. See also P-579.

● **P-900. Evolution of linear programming computing techniques.** William Orchard-Hays. 7-18-56. Unclassified.

A review of the development of linear programming computing techniques. The method was originally applied by hand or with the aid of punched-card equipment. Automatic routines were later designed. RAND has developed general linear programming routines of considerable value by its use of the IBM Model II CPC, the 701, and the 704. 18 pp. Published in *Management Science*, January, 1958. Presented before the Econometric Society at the University of Washington at Seattle, Washington, August 23, 1956.

P-901. A comparison of Soviet and American retail prices in 1950. N. M. Kaplan and E. S. Wainstein. 10-3-56. Unclassified.

A summary of previous work on the retail prices of food and manufactured goods, respectively. It is shown that in 1950 the retail purchasing power of the ruble was on the order of 5 or 6 cents, and that the real wage rate in the Soviet Union was 12 to 16 per cent of the real wage rate in the United States. 38 pp. Illus. Also published as RM-1692-1. Published in *The Journal of Political Economy*, December, 1956.

P-903. On a class of functional equations of modular type. R. E. Bellman. 7-16-56. Unclassified.

An attempt to show how the Voronoi functions and their analogues in the algebraic number, matrix, and finite fields may be used to generate large classes of functions possessing functional equations of modular type. 7 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September, 1956.

P-907. The storage allocation of the linear programming code. H. A. Judd (International Business Machines Corporation). 7-26-56. Unclassified.

A discussion of the handling of storage assignment and subroutine interconnections for the 704 linear programming codes. The available storage of the machine is divided into code and data parts. Their layouts are fairly independent of one another, and the programs include routines for automatic housekeeping during the loading and running of a job. 12 pp. Prepared for RAND's course in Computational Aspects of Linear Programming, given September 4-13, 1956.

P-908. Adaptability of the linear programming codes. William Orchard-Hays. 8-1-56. Unclassified.

An attempt to establish certain principles for designing an elaborate set of computer codes. How easily the resulting changes can be handled is dependent on the organization of the codes and on the assembly program used. The appendix discusses some shortcomings of the assembly program and some suggested improvements. 20 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-909. Operating the linear programming codes. Leola Cutler. 8-1-56. Unclassified.

A method of operating an elaborate set of computer codes. The checks used and the types of error expected are discussed, together with the procedure for computing after machine or problem error has occurred. It is shown that with adequate written instructions the problems can be run on the high-speed computer by any machine operator. 27 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

● **P-910. A min-max solution of an inventory problem.** H. E. Scarf. 6-24-57. Unclassified.

A study of the problem of purchasing a quantity of an item in anticipation of a future demand. It is assumed that only the mean and standard deviation of the demand distribution is known. From this deviation a stock level is determined which maximizes the minimum profit for all demand distributions. The stock level is then compared with the levels obtained by assuming several specific distributions. 16 pp. Illus.

P-911. The revised simplex method. William Orchard-Hays. 8-6-56. Unclassified.

A revision of the simplex method which makes explicit use of columns of the restraint coefficients associated with a basic set of variables. The development is based on the single assumption of linearly independent restraint equations. In addition, an algebraic method of resolving degeneracy is given. 29 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-912. A systematic approach to local objective forecast studies. J. D. Sartor. 11-22-57. Unclassified.

The development of a systematic approach to the preparation of local objective forecast studies. The seasonal, daily, or other cyclic variations of the elements to be forecast are isolated. Correlated (noncyclic) variables are determined using only synoptic data. In addition, several component studies are assembled into a logical forecast scheme. 23 pp. Illus. Published in the *Bulletin of the American Meteorological Society*, January, 1958. Presented before the American Meteorological Society at Albuquerque, New Mexico, September 6, 1956.

P-914. Preparation of input for the linear programming code. H. A. Judd (International Business Machines Corporation). 8-7-56. Unclassified.

A description of the format of alphabetic and decimal input cards, their loading sequence, and the resulting output of the Data Assembly code. 11 pp. Prepared for RAND's course on Computational Aspects of Linear Programming, given September 4-13, 1956.

P-916. The complete dualized system of the simplex method. William Orchard-Hays. 8-9-56. Unclassified.

An extension of the augmented tableau of the revised simplex method to display all relationships involved. The simplex method is applied to the dual system to solve the primal system starting from a solution which is feasible for the dual. 12 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-917. On some applications of dynamic programming to matrix theory. R. E. Bellman. 11-21-56. Unclassified.

An application of the functional equation approach of dynamic programming to the problem of solving the linear system $Ax = c$, where A is approximately a block diagonal matrix. In addition, the eigenvalue problem is considered. 10 pp. See supplement P-1906. Published in the *Illinois Journal of Mathematics*, June, 1957.

P-918. Notes on matrix theory—XIII: slightly intertwined linear programming matrices. R. E. Bellman. 1-23-57. Unclassified.

The use of the functional equation approach of dynamic programming to treat a linear programming problem. This problem involves a slightly intertwined matrix, i.e., one which is almost block diagonal. 5 pp. A condensed version of RM-1859. Published in *Management Science*, July, 1957.

• **P-920. On the mechanism of fatigue.** F. R. Shanley. 8-9-56. Unclassified.

A discussion of a *Philosophical Magazine* article, "The Origin of Fatigue Fracture in Copper," by N. Thompson and others. The experimental results are shown to support a fatigue mechanism proposed earlier by the author. In addition, various theories of fatigue are discussed. 9 pp. Published in *Aircraft Engineering*, January 1957.

P-921. Upper bounded variables in linear programming. G. B. Dantzig and S. M. Johnson. 4-24-57. Unclassified.

A technique for bounding variables in a linear programming problem, together with several applications. These restraints can be applied without greatly increasing the computational effort. 13 pp. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-922. Is "dual" preparedness more expensive? M. W. Hoag. 8-14-56. Unclassified.

A discourse on whether military dual preparedness (i.e., an ability to fight limited wars without the superbomb as well as an ability to retaliate overwhelmingly with it) is more expensive than single preparedness. In view of present U.S. offensive preparations for massive atomic retaliation, funds for added home protection are stressed as a compelling factor in preparedness. 9 pp. Published in the *Bulletin of the Atomic Scientists*, February, 1957.

P-923. Network flow theory. L. R. Ford, Jr. 8-14-56. Unclassified.

A discussion of the labeling algorithm for solving maximal network flow problems and of its application to various problems of the transportation type. 13 pp. Illus. Prepared for RAND's course on the Computational Aspects of Linear Programming, given September 4-13, 1956.

P-924. Computational aspects of dynamic programming. S. E. Dreyfus. 11-19-56. Unclassified.

A discussion of dynamic programming as a mathematical technique useful in analyzing multistage decision processes. Several computational difficulties, characteristic of all dynamic programming processes, are considered. In particular, problems involving the compact representation of functions of several variables and the determination of the maximum value of a function over a multi-dimensional domain are treated. 3 pp. Published in *Operations Research*, June, 1957. Presented before the Operations Research Society of America at San Francisco, California, November 15, 1956.

P-925. Printing and checking for linear programming codes. H. A. Judd (International Business Machines Corporation). 8-23-56. Unclassified.

A description of the print subroutine in the linear programming code. The checking of errors associated with the malfunctioning of the IBM 704 and with problem formulations is discussed. In addition, a sample problem is presented. 27 pp. Tables. Prepared for RAND's course on Computational Aspects of Linear Programming, given September 4-13, 1956.

P-926. Newtonian flow theory for slender bodies. J. D. Cole. 9-25-56. Unclassified.

An examination of the Newtonian flow theory from the viewpoint of gas dynamics and hypersonic small-disturbance theory. A general solution of the first approximation for the flow past slender bodies at zero angle of attack is given. This study may serve as an aid to the aerodynamicist in designing airframes for hypersonic speeds. 33 pp. Illus. Also published as RM-1633. Published in the *Journal of the Aeronautical Sciences*, June, 1957.

P-927-AEC. Thermodynamic properties of mixtures on the statistical model. J. J. Gilvarry and W. G. McMillan. 8-28-56. Unclassified.

A method of deriving Brachman's results for the thermodynamic functions of the Thomas-Fermi atom. This method is presented in a generalized form applicable to mixtures of electrons and light nuclei in the field of a heavy nucleus. 6 pp. Published in *The Physical Review*, January 15, 1957.

P-928. Gradient methods for constrained maxima. K. J. Arrow and L. Hurwicz. 8-28-56. Unclassified.

An application of certain computational methods to evaluate constrained extrema, maxima, or minima. Although the solution of nonlinear games is discussed, the application of the gradient method to constrained maxima is emphasized. 12 pp. Published in *Operations Research*, May, 1957.

P-929. A failure model for equipments undergoing complex operation. D. S. Stoller. 2-18-58. Unclassified.

An examination of a simple failure model for equipment undergoing several cycles of operation. A consequence of this model is that the probability of failure for a given total operating time is dependent on the number of cycles of operation in a simple way. A method is discussed for testing the plausibility of the model against failure data. 8 pp. Illus. Published in *Operations Research*, September–October, 1958. Presented before the Operations Research Society of America at San Francisco, California, November 15, 1956.

P-930. Hypersonic, nonviscous flow around a circular disk normal to the stream. Hyman Serbin. 5-3-56. Unclassified.

An examination of the flow field around a disk immersed in a hypersonic inviscid stream and mounted normal to the free stream. The principal assumption is that the ratio γ of specific heats in the flow behind the shock is near unity. The analysis is limited to first order terms in $\gamma - 1$. 26 pp. Illus. Also published as RM-1713. See also RM-1772, P-1069, and P-1172. Presented before the Institute of the Aeronautical Sciences at Los Angeles, California, April 23, 1957.

• **P-931. Resonance escape probability in natural uranium and H_2O – D_2O mixtures.** George Safonov. 8-30-56. Unclassified.

A computation of the resonance escape probability in homogeneous mixtures of natural uranium by a numerical solution of the Boltzmann equation on the IBM 701. The radiative capture cross section of U^{238} is represented by a block histogram which represents the microscopic cross section as a function of energy and estimates the effective resonance integral. 7 pp. Illus. Presented before the Brookhaven Conference on Resonance Absorption of Neutrons in Nuclear Reactors at Long Island, New York, September 24–25, 1956, and published in the proceedings of the Conference.

P-932. An analytic solution of the warehouse problem. S. E. Dreyfus. 9-6-56. Unclassified.

An attempt to determine, by dynamic programming, a computational algorithm for solving the warehouse problem. It is shown that the structure of the solution can be determined analytically, with numerous results obtained by recursive formulas. 9 pp. Illus. Published in *Management Science*, October, 1957.

• **P-935. Sequential minimax search for a zero of a convex function.** O. A. Gross and S. M. Johnson. 9-11-56. Unclassified.

A procedure for locating the unique root of a function which is continuous, convex, and otherwise unknown, but computable. The root is computed on the starting interval within an interval of minimum guaranteeable length in n steps. It is assumed that a step consists in calculating the value of the function at any point chosen. The pertinent functional equation is derived, and curves of the objective function are plotted for $n = 1, 2, 3, 4$ from data obtained from the JOHNNIAC. 23 pp. Illus. Published in *Mathematical Tables and Other Aids to Computation*, January, 1959. Presented before the Econometric Society at Seattle, Washington, August 23, 1956.

P-936. Costs and benefits in mathematical programming. A. S. Manne. 8-27-56. Unclassified.

An application of linear programming methods to month-to-month airlift planning within the U.S. Military Air Transport Service (MATS). Linear programming methods are substituted for trial-and-error calculations in an attempt (1) to diminish the time required to adapt plans to radical changes in the airlift problems and (2) to increase the productivity of MATS' resources. 18 pp. Illus. Also published as RM-1785. Presented before The Institute of Management Sciences at Los Angeles, California, October 18, 1956.

P-937. The role of the military in post-Stalin Soviet politics. R. L. Garthoff. 9-12-56. Unclassified.

A discussion of the effects of Stalin's death on the role of the military. Certain events in the USSR since 1953 have increased the political status of the military leaders. However, if the political leaders conflict over issues in the future which directly affect military requirements, the military may be forced to become active contestants for power. 22 pp. A revised version of RM-1638. Published in *The Russian Review*, April, 1957.

P-938. On the expansions of some infinite products. R. E. Bellman. 9-14-56. Unclassified.

An expansion for $\prod_{k,l=1}^{\infty} (1 - x^k y^l)$ analogous to the classical expansion of $\prod_{k=1}^{\infty} (1 - x^k)$. 7 pp. Published in the *Duke Mathematical Journal*, September, 1957.

P-939. A systematic approach to a class of problems in the theory of noise and other random phenomena—III: examples. A. J. F. Siegert. 9-17-56. Unclassified.

An application of the method used in P-738 to the problem of finding the characteristic function for the probability distribution of

$$\mathcal{F} \equiv \int_0^t \sum_{j,k} x_j(\tau) K_{jl}(\tau) x_l(\tau) d\tau,$$

with or without conditions on $x_j(0)$ and $x_j(t)$, where the functions $x_j(\tau)$ are the components of a stationary n -dimensional Markoffian Gaussian process $x(\tau)$. 39 pp. See also P-730. Published in the *IRE Transactions on Information Theory*, March, 1958.

P-940. A simple relation between the shock and expansion pressure coefficients for two-dimensional hypersonic flow. J. L. Raymond and E. P. Williams. 1-15-57. Unclassified.

A study showing that a simple relation between the two-dimensional wedge pressure coefficients for shock and expansion applies for the entire hypersonic regime. Consequently, the hypersonic small-disturbance theory expressions for these coefficients and the calculation of pressure distributions on arbitrary two-dimensional configurations at hypersonic speeds are simplified. 3 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, May, 1957.

• **P-941. A feasibility algorithm for one-way substitution in process analysis.** K. J. Arrow and S. M. Johnson. 9-12-57. Unclassified.

A discussion of machines and their capability and of tasks and their decreasing order of difficulty. Assuming that a certain amount of each task to be performed and a certain quantity of each machine are given, an algorithm for assigning the most difficult tasks to the most capable machines is presented to determine whether or not the proposed task program is feasible. 9 pp. Also published as RM-1976. Published as Chapter XIV in *Studies in Linear and Non-linear Programming* by K. J. Arrow, L. Hurwicz, and H. Uzawa, Stanford University Press, Stanford, Calif., 1958. \$7.50.

• **P-942. The combination of time series and cross-section data in interindustry flow analysis.** K. J. Arrow. 9-18-56. Unclassified.

Part of a broader investigation concerned with variations of input-output ratios over time. The present study considers the interindustry flow model implied in the use of both time series and interindustry flow data for estimating the parameters involved. The maximum likelihood estimates for a single equation are derived as the solution of a system of simultaneous equations. 12 pp.

P-943. Impurity-induced localized modes of lattice vibration in a diatomic chain. R. L. Bjork. 9-20-56. Unclassified.

A study of the normal modes of vibration and their associated frequencies in a diatomic chain containing an impurity of mass and force constant different from the atom which it replaces. Localized modes are found which have appreciable components only near the impurity and whose frequencies are displaced from the continua of the optical and acoustic bands into the forbidden gap or above the optical band. 16 pp. Illus. Published in *The Physical Review*, January 15, 1957.

P-945. The Russian future: is a new optimism justified? R. C. Tucker. 9-20-56.

Unclassified.

A discourse on the present and potential social forces in Russia as a justification for a new optimism. Relaxation of the suppressive measures of Stalin have led to, among other changes, a decline of terror, less rigid travel controls, and talk of legality. A possible future innovation considered is the appearance of social forces from the Russian intelligentsia striving for real liberalization. 19 pp. Published under the title "Optimism and Post-Stalin Russia" in *The New Leader*, October 22, 1956.

● **P-946. Poisson's ratio for honeycomb sandwich cores.** G. A. Hoffman. 4-23-57.

Unclassified.

A derivation of Poisson's ratio for a variety of honeycomb cores having cells shaped as hexagons, squares, and rectangles. A relation is obtained between Poisson's ratio of the core and stiffness of the sandwich panel. Conclusions are drawn as to the desirability of using cores with large Poisson ratio. 28 pp. Illus. See condensation P-1330. Published in the *Journal of the Aerospace Sciences*, August 1958.

● **P-947. On positive definite matrices and Stieltjes integrals.** R. E. Bellman. 10-22-56.

Unclassified.

An extension of the Riemann-Stieltjes integral connected with the study of positive definite matrices. This paper considers the variational characterization of the eigenvalues of symmetric matrices in an attempt to determine a Riemann-Stieltjes integral for matrices, which can be extended to many other classes of noncommutative hyper-complex number systems. 8 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series II, Vol. VI, 1957.

● **P-948. A unified process for the evaluation of the zeros of polynomials over the complex number field.** J. I. Derr. 4-30-58. Unclassified.

A generalization of Newton's method for evaluating the zeros of analytic functions by the recurrence relation

$$z_{i+1} = z_i - (k_i - l_i) f^{(l_i)}(z_i) / f^{(l_i+1)}(z_i),$$

where k_i and l_i are determined so that ideally $l_i + 1 = k_i = k$ in the vicinity of a zero of order k . The process so defined is a second-order one and yields accurate approximations to zeros for all values of k , provided $l_i + 1 = k_i = k$. 18 pp. Published in *Mathematical Tables and Other Aids to Computation*, January, 1959.

● **P-949. On the role of dynamic programming in statistical communication theory.**

R. E. Bellman and R. E. Kalaba. 12-19-56. Unclassified.

A study showing that the fundamental problem of determining the utility of a communication channel in conveying information can be viewed as a problem within the framework of multi-stage decision processes of stochastic type. As such, the problem may be treated by means of dynamic programming theory. 20 pp. Published in the *IRE Transactions on Information Theory*, September, 1957.

P-950. Linear programming. R. E. Kalaba. 10-1-56. Unclassified.

A discussion of several examples of linear programming problems, the central mathematical problem, various methods of solution, and lines along which further research is required. The examples of linear programming problems presented deal with transportation, nutrition, and optimal routing. 16 pp. Illus. Published in the *Pacific Electronics Monthly*, November, 1956.

P-951. Empirical explorations of the Logic Theory Machine: a case study in heuristics. A. Newell, J. C. Shaw, and H. A. Simon. 3-14-57. Unclassified.

A discussion of the Logic Theory Machine, a program that discovers proofs for theorems in elementary symbolic logic by means of heuristic devices. This paper presents the results of the program on RAND's Johniac. The program is described, and the role of the various methods and heuristics in contributing to the total problem-solving capability of the machine is evaluated. 49 pp. Illus. See companion piece P-954. Published in the *Proceedings of the Western Joint Computer Conference*, June, 1957. Presented before the Western Joint Computer Conference at Los Angeles, California, February 28, 1957.

P-952. Large data-handling equipment as a commercial tool. J. A. Postley. 11-19-56. Unclassified.

A discussion of the impact of present and future large-scale data-handling equipment as applied to large data-handling problems in the commercial world. 20 pp. Published in *Management Science*, October, 1957, and in *Schede Perforate e Calcolo Elettronico*, January-February, 1958. Presented before the Institute of Management Sciences at Los Angeles, California, October, 1956.

P-953. Meteoric interaction with the atmosphere: theory of drag and heating and comparison with observations. Carl Gazley, Jr. August 1959. Unclassified.

A comparison of meteor theory with observations to obtain information about the mechanisms of aerodynamic drag, aerodynamic heating, and surface ablation. Analytical expressions are developed for meteoroid deceleration, mass loss, and luminosity. The results are expressed in terms of the observational quantities and compared with the more reliable measurements. The comparison indicates that the extension of conventional free-molecule aerodynamics to the meteor case appears to be justified. 58 pp. Illus. Also published as Chapter 6 of R-339. Presented before the RAND Symposium on Aerodynamics of the Upper Atmosphere, June 8-10, 1959.

P-954. Programming the Logic Theory Machine. A. Newell and J. C. Shaw. 2-28-57. Unclassified.

A discussion of the features of the language describing the Logic Theory Machine that was presented in P-951. In addition, some problems connected with the development of this language and other more powerful information processing languages are examined. 34 pp. Illus. Published in the *Proceedings of the Western Joint Computer Conference*, June, 1957. Presented before the Western Joint Computer Conference at Los Angeles, California, February 28, 1957.

P-955. Deceleration and heating of a body entering a planetary atmosphere from space. Carl Gazley, Jr. 2-18-57. Unclassified.

An investigation of the conditions for a safe passage through a planetary atmosphere for instrumented or manned space vehicles, in view of the heating and deceleration to be expected. The dynamics and thermodynamics of several types of entry into the atmospheres of Venus, Earth, and Mars are considered. With the proper planetary approach, successful penetration of these atmospheres appears possible. 56 pp. Illus. Published in *Vistas in Astronautics*, ed. by M. Alperin, M. Stern, and H. Wooster, Pergamon Press, London, England, 1958. \$15.00. Presented before the Astronautics Symposium at San Diego, California, February 19, 1957.

P-956. On the linear differential equation whose solutions are the products of solutions of two given linear differential equations. R. E. Bellman. 10-10-56. Unclassified.

An application of a result in matrix theory to the problem of determining the linear differential equation whose solutions are the products of the solutions of two given linear differential equations. 6 pp. Published in *Bollettino della Unione Matematica Italiana*, Series III, Vol. XII, 1957.

P-958. A recoverable scientific satellite. C. Gazley, Jr., and D. J. Masson. 2-27-57. Unclassified.

A discussion of the possible recovery of an orbiting body of the Vanguard type in an attempt to procure data (1) not obtainable remotely from the orbiting vehicle and (2) for the recovery design of larger instrumented or manned orbital vehicles. For the initial stages of a recovery program, a simple body is suggested which would withstand atmospheric re-entry and final impact. It is assumed that the only payload is the outer skin of the body and a radio beacon. 23 pp. Illus. A revised version of RM-1844. Published in *Aviation Age*, August, 1957.

P-960. Hydrodynamical stability and Poincaré-Lyapunov theory—I. R. E. Bellman and G. M. Wing. 10-13-56. Unclassified.

A paper which initiates a rigorous theory of hydrodynamical stability. An attempt is made to establish results corresponding to the classical Poincaré-Lyapunov theory for systems of nonlinear ordinary differential equations and for classes of nonlinear partial differential equations occurring in hydrodynamics. These results parallel those established for differential-difference equations and for the nonlinear heat equation. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, November, 1956.

P-964. General systems approaches to telecommunication optimization problems.

R. E. Kalaba and M. L. Juncosa. 3-1-57. Unclassified.

An application of linear and dynamic programming to solve numerous communication system problems. Treatments for communication system extension problems and for equipment replacement policies are given, and various generalizations are indicated. 21 pp. Published in the 1957 *IRE National Convention Record* (10 Vols.). Based on three lectures presented before the Institute of Radio Engineers at the California Institute of Technology at Pasadena during January and February of 1957. Also presented before the National Meeting of the Institute of Radio Engineers at New York City, March 18-22, 1957.

P-965. A display technique for planning. J. L. Kennedy. 10-23-56. Unclassified.

A description of a display technique which may be used by teams of planners and decision-makers when faced with the complexities of developing large interacting systems. In particular, it is proposed that the contextual map will substantially assist decision-making in Air Force research and development. 10 pp. A revision of RM-1575. Presented before a Symposium on Personnel, Training, and Human Engineering Research at Washington, D.C., November 16, 1956, and published in the proceedings of the Symposium.

● **P-966. An experiment in symbolic work on the IBM 704.** J. G. Kemeny. 9-7-56. Unclassified.

An experiment designed to demonstrate that the IBM 704 is suitable for at least certain types of symbolic problems. Appendixes to this paper discuss the use of code 64.25 and the outcome of the experiment. 18 pp.

● **P-967. Constructing maximal dynamic flows from static flows.** L. R. Ford, Jr., and D. R. Fulkerson. 9-17-57. Unclassified.

An outline of a method for constructing maximal dynamic flow from static flow and a presentation of a simple proof of maximality. It is assumed that for a given network of nodes and arcs (e.g., a railway system) each arc has associated with it two positive integers. These integers consist of a commodity-flow capacity and a commodity-traversal time. 31 pp. Illus. Also published as RM-1981. Published in *Operations Research*, June, 1958. Presented before the Conference on Linear Programming at Princeton University, Princeton, New Jersey, March 12-13, 1957.

P-968. Scientific progress and political science. Bernard Brodie. 11-30-56. Unclassified.

A speech delivered before the American Association for the Advancement of Science at New York City, December 26, 1956, on the deficiency of political scientists in coping with policy decisions affecting national security in an atomic age. The causes for this deficiency are enumerated (e.g., the security barrier, the exaggeration of the esoteric nature of the military art, the rampant technology in the art, and the weight of tradition in determining scope and method in political science). 21 pp. Published in *The Scientific Monthly*, December, 1957.

P-969. SHARE: a eulogy to cooperative effort. Paul Armer. 10-31-56. Unclassified.

A discussion of the history of cooperative effort in the scientific computing field. In particular, the history of SHARE (described as a users' cooperative consisting of organizations who have, or plan on, an IBM Type 704 electronic data-processing machine) is investigated. It is recommended that similar groups be formed to serve those interested in other areas of data processing. 22 pp. Published in the *Proceedings of the Second Annual Electronic Business Systems Conference at San Francisco, California*, November 8-9, 1956. Presented before the Electronic Business Systems Conference at San Francisco, California, November 8, 1956.

● **P-971. Elements of a theory of human problem solving.** A. Newell, H. A. Simon, and J. C. Shaw. 3-4-57. Unclassified.

A discussion of such elements of a theory of human problem solving as (1) how human problem solving occurs, (2) what processes are used, and (3) what mechanisms perform these processes. It is shown that the overt behavior of the Logic Theory Machine and the processes it uses are similar to those of a human confronted with the same problems in logic. 39 pp. Published in *Psychological Review*, May, 1958. Presented before an interdepartmental seminar at Yale University, New Haven, Connecticut, November 29, 1956, and before the American Psychological Association at New York City, September 5, 1957.

P-972-RC. Soviet economic aid in Southeast Asia: threat or windfall? Charles Wolf, Jr. 12-6-56. Unclassified.

A discourse on the new Soviet diplomacy in Asia, that of extending economic aid to a select group of countries who qualify as nonallied with the United States. Such questions are examined as (1) Is Soviet aid in Southeast Asia a clear threat to U.S. interests? (2) Should offers of aid by the Bloc be matched by U.S. counteroffers of more aid on more favorable terms? and (3) What can be said about the effect of Soviet aid to nonallied countries in our SEATO allies? 15 pp. Tables. Published in *World Politics*, October, 1957. Presented before a group at the Associated Colleges of Claremont, Claremont, California, March 15, 1957.

P-973. The Logistics Laboratory: hopes and plans. M. A. Geisler. 11-9-56. Unclassified.

A discussion of the purposes and nature of the Logistics Systems Laboratory. This laboratory may provide a useful research tool for examining the impact of proposed logistics policy changes upon the reporting systems and organizational structures. 13 pp. Illus. Presented before the RAND Military Advisory Group at Maxwell Air Force Base, Montgomery, Alabama, October, 1956.

P-975. A calculation of the blast wave from a spherical charge of TNT. H. L. Brode. 5-26-58. Unclassified.

A description of the blast wave from the detonation of a spherical charge of TNT. The equations of motion and the equations of state for TNT and for air are examined. The pressures, densities, temperatures, and velocities are given as functions of time and radius. Space-time relations and energy and impulse histories are discussed. Results show that a second shock originates as an imploding shock following the inward rarefaction into the explosion product gases and that a series of subsequent minor shocks appear in a similar manner, moving out in the negative phase behind the main shock. 52 pp. Illus. A revision of RM-1965. Published in *The Physics of Fluids*, March-April, 1959.

P-976. On the principle of invariant imbedding and diffuse reflection from cylindrical regions. R. E. Bellman and R. E. Kalaba. 11-14-56. Unclassified.

A continuation of P-839 in which the principle of invariant imbedding was introduced as an extension of the ideas of Ambarzumian and Chandrasekhar and used to treat the case of inhomogeneous plane-parallel regions. The present paper shows that this new concept treats cylindrical, and analogously spherical, geometries in a unitary fashion and provides an answer to the query of Chandrasekhar. 6 pp. Illus. See also P-996, P-1102, P-1252, P-1380, P-1390, P-1495, and T-63. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, June, 1957.

P-977. A dynamic programming solution to a cascading problem arising in heavy water production. R. E. Bellman. 11-14-56. Unclassified.

A study to determine the most efficient cascading process arising in heavy water production. Previous authors have solved this multi-dimensional maximization problem using an iterative technique. The present paper solves the problem by the theory of dynamic programming. 7 pp. Published in *Nuclear Science and Engineering*, July, 1957.

● **P-978. The atmosphere of Venus.** S. H. Dole. 10-12-56. Unclassified.

Deductions concerning the structure and composition of the atmosphere of Venus. The depth of the atmosphere is estimated from an empirical correlation of published data on the dimensions, masses, and densities of the terrestrial planets. The composition of Venus' atmosphere is inferred by hypothetically placing the Earth in Venus' orbit and examining the various effects. 30 pp. Illus. Presented before the Lunar and Planetary Exploration Colloquium at Hawthorne, California, March 18, 1959, and published in the proceedings of the Colloquium.

P-980. Concepts, origins, and use of linear programming. G. B. Dantzig. 3-7-57. Unclassified.

A discussion of linear programming as a technique for building a model that describes the interrelations of the components of a system. The industrial and military applications of this technique are reviewed. In addition, an example is presented which illustrates the principles of the linear programming approach. 18 pp. Published in the *Proceedings of the First International Conference*

- P-982. Bounds on the expectation of a convex function of a random variable. H. P. Edmundson. 4-9-57. Unclassified.

A derivation (using the theory of moment spaces) of upper and lower bounds on the expectation of a convex function of a random variable. The lower bound obtained agrees with that of classical analysis, while the upper bound is believed to be a new result. 6 pp.

- P-983. Deterrence is not enough. G. C. Reinhardt. 6-4-58. Unclassified.

An appraisal of the deterrence concept as a policy of the United States. Our deterrence to date has been weakened by the lack of a comprehensive, positive political strategy. Only by conducting a sustained political-ideological offensive against the weaknesses of the Communist system can the United States keep her foes off balance and prevent their constant encroachments in the free world. A defense based on deterrence alone will eventually lead to disaster, and cold war offensives are essential and become feasible when operations are unified on a national level. 22 pp.

- P-984. The tragedy of Hungary: a revolution won and lost. R. L. Garthoff. 11-28-56.

Unclassified.

A discourse on the recent Hungarian revolution. The background and consummation of the revolution are discussed, together with the Soviet offensive. It is concluded that the tragedy of the revolution occurred when Hungary withdrew from the Warsaw Pact, thereby threatening (in Soviet eyes) to place a Western base on the borders of the S.U. and to dynamite the entire satellite empire. 40 pp. Published in the *Problems of Communism*, January-February, 1957.

- P-985-AEC. The correlation energy of an electron gas at high density. M. Gell-Mann and K. A. Brueckner. 11-29-56. Unclassified.

A discussion of the idealized problem of the ground state energy of a gas of electrons in the presence of a uniform background of positive charge that makes the system neutral. The quantity ϵ_c is defined as the correlation energy per particle of an electron gas expressed in Rydbergs. It is a function of the conventional dimensionless parameter r_s , where r_s^{-3} is proportional to the electron density. The method of computation is based on summing the most highly divergent terms of the perturbation series under the integral sign to give a convergent result. 18 pp. Illus. See companion piece P-988. Published in *The Physical Review*, April 15, 1957.

- P-986. Engineering test reactors with large central irradiation cavities. George Safonov. 11-1-56. Unclassified.

An extension of RM-1835, *The Criticality and Some Potentialities of Cavity Reactors*, which suggests that a first natural application of the cavity concept would be for test reactor purposes since a large irradiation volume is inherent to the concept. As the necessary high flux is obtained with a low critical mass if reasonable power densities are achieved, the present paper shows that a cavity test reactor with some 4000 liters of central irradiation space may achieve MTR (materials testing reactor) flux levels while operating with MTR fuel plates under established conditions. 6 pp. Illus. Published as a "Letter to the Editor" in *Nuclear Science and Engineering*, January, 1957.

- P-987. Problem solving in humans and computers. A. Newell, J. C. Shaw, and H. A. Simon. 12-7-56. Unclassified.

A comparison of the "thinking" processes of modern electronic computers and human beings. In addition, research in psychology that is using electronic computers to reach an understanding of human mental processes is discussed. 12 pp. Published in *Carnegie Technical*, March, 1957. Presented before an interdepartmental symposium at the Carnegie Institute of Technology, Pittsburgh, Pennsylvania, November 14, 1956.

- P-988-AEC. The specific heat of a degenerate electron gas at high density. Murray Gell-Mann. 12-5-56. Unclassified.

A generalization of P-985-AEC, *The Correlation Energy of an Electron Gas at High Density*, in that not only the ground state but also the low excited states of an electron gas are discussed. The specific heat of the gas at low temperature is proportional to the density of single particle levels at the surface of the Fermi sea, or inversely proportional to $[(dw/dp)_{p=1}]$. This last quantity is calculated for high density (small r_s , where density is proportional to r_s^{-3}) and compared with the corresponding quantity for a free electron gas. 12 pp. Published in *The Physical Review*, April 15, 1957.

P-989. Sequential production planning over time at minimum cost. S. M. Johnson. 2-4-57. Unclassified.

A method for solving the problem of producing a given commodity scheduled over time to meet known future requirements while minimizing total costs. The costs include both storage and production costs as functions of time. The unit production cost is an increasing function of the production rate. 8 pp. Published in *Management Science*, July, 1957.

- **P-990. Network flow and systems of representatives.** L. R. Ford, Jr., and D. R. Fulkerson. 12-11-56. Unclassified.

An application of some basic theorems of network flow theory to determine necessary and sufficient existence conditions for a system of representatives for a collection of subsets of a given set. It is assumed that each element a_i of a given set occurs at least α_i times in the system and at most β_i times (a system of restricted representatives). In addition, the existence of a common system of restricted representatives is examined for two different collections of subsets of the given set. 15 pp. Published in the *Canadian Journal of Mathematics*, Vol. X, No. 1, 1958.

P-991. Some principles for a data-processing system in logistics. M. A. Geisler. 12-12-56. Unclassified.

A discussion of some principles and concepts of a revised logistics data-processing system proposed for the Air Force that have been developed at RAND. These ideas provide a general framework in which a data-processing system capable of meeting the operational needs of the 1960's might be developed. Although particularly applicable to the Air Force, this study may be relevant to the other military services and industry in general. 20 pp. Illus. Published in the *Naval Research Logistics Quarterly*, June, 1958.

P-993-RC. Japan's economic future in Asia. Donald Stout. 12-14-56. Unclassified.

A discourse on (1) the interaction of Japanese economic activity with the future economic trends in Asia and (2) the objectives of Japan simultaneously to eliminate its dollar import balance, to pay reparations, and to expand trade with Asia. The implications of these findings are examined in relation to United States foreign policy. 111 pp. Tables.

P-994. Theory of games of strategy. Melvin Dresher. 12-17-56. Unclassified.

A survey of the mathematical theory of zero-sum two-person games. In particular, this study describes games with a finite number of strategies, the solution of finite games, games with infinite strategies, and examples of infinite games. 14 pp. Published in *Applied Mechanics Reviews*, April, 1957. Presented before the American Institute of Electrical Engineers at Los Angeles, California, April 11, 1957, and before the Mathematical Association of America at San Diego, California, April 11, 1957.

- **P-995. Queueing with balking.** F. A. Haight. 12-18-56. Unclassified.

A study of a queueing situation where the arrivals and service times are exponential. Each individual arriving at the queue has a predetermined integer K (which varies randomly from one individual to the next) such that he joins the queue if and only if its length does not exceed K . The distribution of queue lengths is obtained for the above case and for some more general models where arrivals and departures may be in bulk and two queues may be joined in tandem. 25 pp. Table. Published in *Biometrika*, December 1957.

P-996. On the principle of invariant imbedding and one-dimensional neutron multiplication. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 12-19-56. Unclassified.

A new method of treating problems involving neutron multiplication by fission with emphasis on questions of critical mass and distribution of neutrons. The results are deduced from applications of the principle of invariant imbedding. 8 pp. See also P-839, P-976, P-1102, P-1252, P-1380, P-1390, P-1495, and T-63. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, June, 1957.

- P-999-RC (out of print). Operations research and government budgets. R. N. McKean. 3-7-57. Unclassified.

The application of operations research to government budget formulation. Two sizes of a program in the U.S. Forest Service are compared, and it is shown how these results may be used in a performance budget. Because of its applicability to different types of programs, operations research may aid in improving the performance of other government activities. 19 pp. Tables.

- P-1000. On a routing problem. R. E. Bellman. 12-20-56. Unclassified.

An attempt to determine an optimal route from one point to another, given a set of N cities, with every two linked by a road, and the times required to transverse these roads. The times are not directly proportional to the distances because of the varying quality of roads and quantities of traffic. The functional equation technique of dynamic programming, combined with approximation in policy space, yields an iterative algorithm which converges after a finite number of iterations bounded in advance. 7 pp. Published in the *Quarterly of Applied Mathematics*, April, 1958.

- P-1002-AEC. The characteristic energy loss of electrons passing through metal foils—II: dispersion relation and short wave length cutoff for plasma oscillations. R. A. Ferrell. 12-28-56. Unclassified.

An attempt to determine the shortest wave length at which plasma oscillations can be sustained by a degenerate electron gas. A method is used to provide a direct quantum mechanical analog to the Bohm-Gross derivation of the dispersion relation. The effect of electron exchange decreases somewhat the dependence of the plasma frequency on wave number. The maximum wave number corresponds sufficiently to the momentum to cause an electron at the surface of the Fermi sea to make a real transition, absorbing one plasma quantum of energy. 32 pp. Illus. Published in *The Physical Review* in two parts: in the January 15, 1956, issue and in the July 15, 1957, issue.

- P-1003. Dynamic programming and stochastic control processes. R. E. Bellman. 1-27-58. Unclassified.

An application of dynamic programming to stochastic control processes. The problem treated is that of determining optimal feedback control to neutralize the effect of random disturbances. In particular, a system S is considered specified at any time t by a finite dimensional vector $x(t)$, satisfying a vector differential equation $dx/dt = g(x, r(t), f(t))$, $x(0) = c$. It is assumed that c is the initial state, $r(t)$ is a random forcing term possessing a known distribution, and $f(t)$ is a forcing term. 20 pp. A revision of RM-1904. Published in *Information and Control*, September, 1958.

- P-1004. On the optimization of two-stage rockets. Martin Goldsmith. 1-29-57. Unclassified.

An attempt to determine the optimum distribution of weight for a two-stage tandem rocket for the case of different structural factors and propellant specific impulses in each stage. The criterion of optimization used is the minimization of gross weight for a given required burnout velocity and payload. 9 pp. Illus. Also published as RM-1796. Published in *Jet Propulsion*, April, 1957.

- P-1008. Reliability and the computer. W. H. Ware. 2-20-57. Unclassified.

An examination of the meaning of reliability in a computing system. The contrast between analog and digital systems in this respect is discussed. In addition, applications for providing reliable computing system operation are developed. 19 pp. Published in the *Proceedings of the Western Joint Computer Conference*, June, 1957. Presented before the Western Joint Computer Conference at Los Angeles, California, February 26, 1957.

- P-1010. Continuous production and emergent demand. T. A. Goldman. 7-9-57. Unclassified.

An examination of a model of the real and monetary costs involved in supplying spare parts from current production. The model leads to a cost function for each part individually depending on its production characteristics, its demand-probability function, and certain policy variables. By choosing appropriate values for the policy variables, the cost function for each part can be minimized independently of the others. 12 pp. Presented before the Operations Research Society of America at Philadelphia, Pennsylvania, May 9, 1957.

- P-1011. A simple relationship between the shock and expansion pressure coefficients as a basis for studying two-dimensional hypersonic flow. J. L. Raymond. 1-15-57. Unclassified.

A description of how a simple relation between the two-dimensional wedge pressure coefficients for shock and expansion applies for the entire hypersonic regime. As a consequence, the hypersonic small-disturbance theory expressions for these coefficients are further simplified as are calculations of pressure distributions on arbitrary two-dimensional configurations at hypersonic speeds. 52 pp. Illus. Published in the *Journal of the Aeronautical Sciences*, May 1957.

- P-1012. A note on monotone convergence to solutions of first-order differential equations. R. E. Bellman. 1-16-57. Unclassified.

An attempt to show that a monotone increasing sequence of approximations can be obtained to the solution of the differential equation $du/dt = \phi(u, t)$, $u(0) = c$. It is assumed that $\phi(u, t)$ is a twice differentiable convex function of u in some t -interval $[0, t_0]$. Similarly, monotone decreasing sequences can be obtained if ϕ is concave. 6 pp. Published in the *Proceedings of the American Mathematical Society*, December, 1957.

- P-1015. On gradient methods for approaching constrained maxima. K. J. Arrow, L. Hurwicz, and T. Marschak. 2-1-57. Unclassified.

A summary of the authors' previous work on gradient methods. The possibility is discussed of convergence in the large when gradient methods are applied to linear programming problems. In addition, computational difficulties encountered in applying the authors' methods to linear programming problems are examined. 21 pp. Tables. Published as a chapter of *Studies in Linear and Non-linear Programming* by K. J. Arrow, L. Hurwicz, and H. Uzawa, Stanford University Press, Stanford, Calif., 1958. \$7.50.

- P-1017. Generalized analysis of aerial campaigns against strategic targets. Richard Schamberg. 5-9-57. Unclassified.

A technique for determining directly the outcome of optimal aerial bombing or reconnaissance campaigns against strategic targets without the usual examination of variations in attack strategy. 39 pp. Illus. Presented before the Operations Research Society of America at Philadelphia, Pennsylvania, May 9-10, 1957.

- P-1018. Notes on matrix theory—XIV: on the Jacobi relation for the bracket symbol. R. E. Bellman. 2-12-57. Unclassified.

A derivation of the Jacobi relation for the bracket symbol using the associative property of exponential matrices. 3 pp. Published in *The American Mathematical Monthly*, October, 1958.

- P-1019. Dispersion in the upper atmosphere. R. R. Rapp and J. G. Edinger. 2-7-57. Unclassified.

An analysis of transosonde balloon data to estimate the dispersion on a large scale in the upper atmosphere. An expression for the autocorrelation function is inferred from synoptic experience and is applied to autocorrelation values computed from the balloon data. Taylor's theorem is applied to this function to compute dispersion out to ten days. A comparison is made with direct computation at two days. 18 pp. Illus. Published in the *Journal of Meteorology*, October, 1957.

- P-1020. The random functions of cosmic-ray cascades. T. E. Harris. 2-7-57. Unclassified.

A presentation of some theorems concerned with the stochastic processes arising in the theory of the soft component of cosmic radiation, as formulated by Bhabha and Heitler and by Carlson and Oppenheimer. Limit theorems are given, and the relation to a certain Markov process is indicated. 4 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, June, 1957. Presented before the Institute of Mathematical Statistics at Atlantic City, New Jersey, September 11, 1957.

- P-1021. Tracking and communication for a moon rocket. R. T. Gabler and H. R. O'Mara. 4-22-57. Unclassified.

A discussion of certain phases of the over-all problem of sending an instrument package to the moon to telemeter scientific information. This paper is specifically concerned with tracking the

vehicle after it is placed on a proper trajectory and telemetering information after it lands. 29 pp. Illus. Published in *Vistas in Astronautics*, ed. by M. Alperin, M. Stern, and H. Wooster, Pergamon Press, London, England, 1958. \$15.00. Presented before the Astronautics Symposium at San Diego, California, February 18, 1957.

- **P-1022. Accuracy requirements for trajectories in the earth-moon system.** H. A. Lieske. 2-19-57. Unclassified.

An investigation of the accuracy requirements on the initial velocity vector for unpowered, or ballistic-type, vehicles for several typical missions in the earth-moon system. These requirements are found to be of the order of 100 ft/sec in magnitude and 1 deg in direction merely to hit the moon or to pass near the moon and return to some place on the earth. 12 pp. Illus. Published in *Vistas in Astronautics*, ed. by M. Alperin, M. Stern, and H. Wooster, Pergamon Press, London, England, 1958. \$15.00. Presented before the Astronautics Symposium at San Diego, California, February 19, 1957.

- **P-1023. Properties of the atmosphere and ionosphere between 90 and 300 km.** H. K. Kallmann. 4-16-57. Unclassified.

A presentation of recent results of upper atmosphere physics which have emerged from experimental and theoretical studies of high-altitude research. These results show that (1) the ionosphere does not consist of ionized layers but rather of continuous densely ionized regions and (2) the true height of reflection of radio waves is considerably lower than the apparent height. 5 pp. Presented before the Astronautics Symposium at San Diego, California, February 18, 1957.

- P-1025. Klaus Knorr on war potential: a brief review.** M. W. Hoag. 11-18-57. Unclassified.

A book review of *The War Potential of Nations* by Klaus Knorr (Princeton University Press, Princeton, N.J., 1956. \$5.00). To emphasize mobilizable war potential, Professor Knorr considers the case in which a nation mobilizes its strength fully after hostilities have begun. Unfortunately, he does not deal at any length with either the all-out war that would wreck mobilization bases, or sharply limited wars. 4 pp. Published in *The Journal of Political Economy*, August, 1957.

- **P-1026. The games-theoretical approach to organization theory.** Olaf Helmer. 2-19-57. Unclassified.

A proposal that an effort be made to enhance the applicability of game theory and organization theory, as both are concerned with the interactions of the decisions of a group of people acting under given constraints. Suggestions are outlined for a tentative program establishing the relationship of these fields to overcome their present difficulties. 14 pp. Presented before the Conference on Game Theory at Princeton University, Princeton, New Jersey, March 12-13, 1957.

- **P-1028. On the status of multistage linear programming problems.** G. B. Dantzig. 2-20-57. Unclassified.

A survey of the kinds of structures encountered and the methods proposed for solving multistage linear programming problems. The single and multicommodity warehouse problem is used to illustrate some basic ideas. In addition, the study discusses the possibility of solving a dynamic problem from a steady-state problem, the need for solving large-scale systems, and the methods for solving block triangular systems. 34 pp. Illus. Published in the *Proceedings of the International Statistical Institute, Held at Stockholm, Sweden, 1957*, and in the *ISI Bulletin*, Vol. 36, Part 3. Also published in *Management Science*, October, 1959.

- P-1029. Dynamic programming: methods and application.** S. E. Dreyfus. 10-6-58. Unclassified.

A study of dynamic programming, defined as a mathematical technique applicable to multistage decision problems. It is shown how a functional equation for finite processes may be solved recurrently and the optimal policy determined. Applications are examined in the fields of mathematics, logistics, economics, military planning, and physics. 13 pp. Presented before the High-speed Computer Conference at Louisiana State University, Baton Rouge, March 8, 1957.

P-1030. Operations research: a new science? M. W. Hoag. July 1957. Unclassified.
A discussion of operations research as a new science of decisionmaking. The role of analytic models in OR is considered, together with computational, criterion, and data problems. 10 pp. Published in *The Journal of Business*, July, 1957. Presented before the Western Spectroscopy Association at Santa Monica, California, January 24, 1957.

P-1032. Scientific aids to decisionmaking: a perspective. F. R. Collbohm. 1-31-57. Unclassified.

A discourse on both scientific and unscientific methods of decisionmaking. The need is stressed for relying on well-designed analyses which define the problem, clarify the objectives, and separate the problem into workable components. In this manner, both expert judgment and new mathematical tools may be applied to provide a sound basis for intelligent decisionmaking. 10 pp. See also P-1042. Published in the *General Management Series*, No. 187. Presented before the General Management Conference of the American Management Association at Los Angeles, California, January 31, 1957.

P-1033. Analytical approximations, volume XXI. C. Hastings, Jr., and E. Hastings. 3-4-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, and P-607. 10 pp. See also P-1098, P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

P-1034-RC. Feather River water for Southern California. J. C. DeHaven and J. Hirshleifer. 2-20-57. Unclassified.

An attempt to estimate the role which water supply from the Feather River Project (a water resource scheme designed to redistribute the waters of California) should play in the calculations of Southern California. It is concluded that alternative measures have not been adequately considered and that no convincing economic justification of the Project has yet been presented. 27 pp. Tables. Published in the *Land Economics*, August, 1957. Presented before the Econometric Society at Cleveland, Ohio, December 27, 1956.

P-1035. What is a system? M. W. Hoag. 3-5-57. Unclassified.

An attempt to define a "system" as a set of interrelated actions about which policy decisions are made. The difference between the administrator and analyst's approach in defining a system is discussed, and several examples are given to illustrate this variance. 6 pp. Published in *Operations Research*, June, 1957.

P-1036. Relationships between weapons and logistics expenditures. M. A. Geisler. 8-28-56. Unclassified.

A discussion of the trade-offs made between investing in a weapon and its logistics support. This study examines (1) some logistic implications of the present need to maintain a high level of operational readiness of the Air Force, (2) the nature of the relationships among weapons, supply support, and maintenance support, and (3) the problem of allocation. 28 pp. Illus. Also published as RM-1786. Published in the *Naval Research Logistics Quarterly*, December, 1957.

P-1038. Dynamic programming and the variational solution of the Thomas-Fermi equation. R. E. Bellman. 3-14-57. Unclassified.

A numerical technique for integrating nonlinear differential equations satisfying two-point boundary conditions which arise from variational problems. The theory of dynamic programming is applied to the minimization problem considered, and two approaches are given. However, the computational results are not presented. 8 pp. Published in the *Journal of the Physical Society of Japan*, September, 1957.

• **P-1039. A generalized equipment replacement study.** S. E. Dreyfus. 3-15-57. Unclassified.

A study of the functional equation technique of dynamic programming to determine the optimal age of replacement of durable machinery. The paper discusses Bellman's analytic solution of a simplified model, a computation scheme applicable to more realistic models, and various dynamic programming formulations applicable in the field of equipment replacement. 18 pp. Illus. Published in the *Journal of the Society for Industrial and Applied Mathematics*, September 1960.

P-1040. Seasonal changes in day-to-day variability of upper air winds near the 100 km level of the atmosphere. E. H. Vestine. 6-6-57. Unclassified.

A paper which shows that the daily variation in ionospheric F-region critical frequencies near noon is probably a good indicator of day-to-day changes in wind speeds in the E-region. The day-to-day changes in wind speed indicated for the E-region in middle latitudes are found to be largest in northern winter, and least in northern summer. In addition, changes in wind speed with sunspot cycle are discussed. 29 pp. Illus. Published in the *Transactions of the American Geophysical Union*, April, 1957.

● **P-1041. War games.** R. D. Specht. 3-18-57. Unclassified.

A description of several examples of war games and a discourse on the problems and values of gaming. The games considered include large and small, high level and low, detailed and aggregated ones. Some of these games use human umpiring while others make their assessments mechanically. 20 pp. Published in *Operational Research in Practice*, ed. by Max Davies, Pergamon Press, London, England, 1958. \$12.00. Presented before the NATO Conference on Operational Research at Paris, France, April 11, 1957.

P-1042. Scientific aids to decisionmaking: a perspective. J. R. Goldstein. 3-19-57. Unclassified.

A discussion of the historical use of the committee in decisionmaking. It is suggested that the scientific method is better for this purpose, because it defines the problem properly, considers real objectives, provides a framework for solving problems of broad scope, and evaluates solutions on the basis of carefully drawn criteria. 12 pp. See also P-1032. Presented before the NATO Conference on Operational Research at Paris, France, April 9, 1957.

● **P-1043. Comments on the sociology of management.** D. G. Hays. 7-11-57. Unclassified.

A description of the functions of management and the relationship between sociology and management. In addition, several problems precipitated by automation are discussed: authority reassignments, changing career lines, and the growing need for explication of factors in human judgment. 16 pp. Illus. Presented before a meeting (sponsored by The Institute of Management Sciences and the Operations Research Society of America) at the University of California at Los Angeles, April 19, 1957.

P-1044. Principles of self-contained navigation. H. H. Bailey. 3-29-57. Unclassified.

An analysis of the basic functions of all navigation. Several methods of fixing and dead-reckoning are discussed, and basic principles of inertial navigation are developed. It is shown that celestial navigation is limited by an inherent difficulty in establishing an accurate vertical on board a moving vehicle and that the first navigation system to be free of fundamental limitations is the one using a doppler radar and a gyroscopic heading reference. 18 pp. Illus. Published in the *Aeronautical Engineering Review*, August, 1957. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, June 19, 1957.

P-1045. A note on an industrial replacement process. S. E. Dreyfus. 3-27-57. Unclassified.

An application of the functional equation technique of dynamic programming to an industrial replacement process occurring in the tire manufacturing industry. A problem posed by M. W. Sasieni, and analyzed as a Markov chain process, is reconsidered from the viewpoint of dynamic programming. 8 pp. Tables. See also P-1066. Published in the *Operational Research Quarterly*, December, 1957.

● **P-1046. The influence of structural materials on the weight, capability, and cost of a weapon system.** V. D. Zahner. 4-1-57. Unclassified.

A discussion of the influence of materials on aircraft structural weight in terms of mechanical properties, type of structure, and loading. The effect of structural materials on aircraft performance is studied in the form of the target coverage capability of strategic bombing systems using various amounts of refueling. In addition, a method of comparing systems involving different structural materials is shown with reference to total system cost for a given job. 42 pp. Illus. Presented before the Society of Aeronautical Weight Engineers at Wichita, Kansas, April 29–May 2, 1957.

P-1047. Soviet trade and aid: trickle or torrent? Hans Heymann, Jr. 2-14-57. Unclassified.

An investigation of (1) the relationship between the growth of the Soviet economy and its participation in foreign trade and technical assistance and (2) the likely impact of the Soviet economic offensive. This paper is a revised version of a formal statement presented at the Hearings before the Subcommittee on the Foreign Economic Policy of the Joint Economic Committee, December 13, 1956. 12 pp. Tables. Published in the *Hearings before the Subcommittee on Foreign Economic Policy of the Joint Economic Committee*, Congress of the United States, 84th Congress, 2d Session, December 10, 12, and 13, 1956, U.S. Government Printing Office, Washington, D.C., 1957.

P-1048. Soviet labor and the question of productivity. J. G. Gliksman. 3-29-57. Unclassified.

A discussion of recent changes in Soviet labor policy which have been forced upon the Soviet leadership by the logic of the new socio-economic order. The reforms discussed were dictated by the need to adjust labor policy to the requirements of technological progress. The effects of the wage reform were devised primarily to maximize labor productivity by increasing the pressure on the workers rather than by bettering their position directly. 16 pp. Published in the *Monthly Labor Review*, June, 1957, and in *The New Leader*, September 9, 1957. Presented before the Industrial Relations Research Association at Washington, D.C., April 19-20, 1957.

P-1050. On the detection of stochastic signals in additive normal noise—part I. David Middleton. 4-1-57. Unclassified.

An examination of optimum and suboptimum detection of normal signals in additive normal noise backgrounds. General results for optimum receiver structure, error probabilities, and average risk are obtained for colored noise backgrounds, and threshold reception in white noise backgrounds is considered. In addition, optimum detector structures, for signal processes with rational intensity spectra, are determined for the white noise case. 124 pp. Illus. Also published as RM-1770. Published in *IRE Transactions on Information Theory*, June, 1957.

• **P-1051. The economics of Navy pay.** A. C. Enthoven. 4-2-57. Unclassified.

A defense of the principle of differential pay in the Navy, based upon supply and productivity considerations. The author argues that the primary objective in the choice of salaries ought to be the maximization of the total effectiveness of the service as a fighting force, within the limitations of the budget. This implies that each man's salary should be proportional to what he adds to total effectiveness. 18 pp.

P-1052. The psychological factor in Soviet foreign policy. R. C. Tucker. 3-7-57. Unclassified.

A study of the implications of Stalin's death for changing the motivation of Soviet foreign policy. During the Stalinist era foreign territory and people participating in the cult of the USSR were totally controlled, the world was divided between two antagonistic camps, and the notion of political neutrality was excluded in world politics. In the post-Stalin period a new expansionism of Soviet influence arose to create new spheres of influence, and the competition for preponderance in third states caused the two-world image to disappear. 33 pp. Also published as RM-1881. Published in the *Problems of Communism*, May-June, 1957.

P-1053. The prospects of a unified theory of organizations. Olaf Helmer. 4-3-57. Unclassified.

A suggestion that a unified theory of organizations be achieved by establishing the relationship in terminology between game theory and organization theory and by using an engineering approach to the psychological problems involved. 11 pp. Published in *Management Science*, January, 1958. Presented before a meeting (sponsored by The Institute of Management Sciences and the Operations Research Society of America) at the University of California at Los Angeles, April 19, 1957.

• **P-1054. Application of operations research to development decisions.** B. H. Klein and W. H. Meckling. 3-3-58. Unclassified.

A discourse on the difference between an efficient allocation of the development budget and the efficient conduct of a current operation. An attempt is made to show that the problem is essentially

not one of choosing among specific end-product alternatives, but rather of choosing a course of action initially consistent with a wide range of such alternatives and of narrowing the choice as development proceeds. 18 pp. Published in *Operations Research*, May-June, 1958. Presented before the Operations Research Society of America at Pittsburgh, Pennsylvania, November 15, 1957.

P-1055. Design change impacts on airframe parts inventories. J. W. Petersen and W. A. Steger. 10-31-57. Unclassified.

An examination of the impacts of design changes upon Air Force inventories of delivered airframe spare parts. The impacts discussed include engineering obsolescence costs, modification costs, contractor design-termination costs, and the costs of parts the applicability of which is limited by a design change. The measures of obsolescence developed are based primarily on the experience of the F-94 series of aircraft. 29 pp. Illus. A revision of RM-1867. Published in the *Naval Research Logistics Quarterly*, September, 1958.

P-1056. On the construction of a multi-stage, multi-person business game. R. E. Bellman, C. Clark, C. Craft, D. G. Malcolm, and F. Ricciardi. 11-21-57. Unclassified.

A discussion of a multi-stage, multi-person, business game to be used for executive training purposes by the American Management Association. The basic philosophy of game play is analyzed, together with the difficulties encountered in constructing business games. Several features of the particular game considered are presented: the absence of an explicit criterion function, the principle of marginal change, hidden formulas, and minimal computation. 63 pp. Illus. Published in *Operations Research*, August, 1957.

P-1058. The politics of Soviet de-Stalinization. R. C. Tucker. 4-15-57. Unclassified.

A discussion of the Soviet political system as a command and control structure and of a concept of Stalinism as a political form. Against this background, the author investigates the meaning, motives, and limits associated with de-Stalinization. It is indicated that the future of internal Soviet politics may revolve in some measure around the clash between the official and unofficial concepts of this issue. 57 pp. Also published as RM-1874. Published in *World Politics*, July, 1957.

P-1059. Chemical equilibrium in complex mixtures. W. B. White, S. M. Johnson, and G. B. Dantzig. 10-8-57. Unclassified.

A method for determining the equilibrium composition of complex mixtures. Based on the minimization of free energy, this method states the problem with simplicity. Specific computation procedures shown are one using a steepest descent technique applied to a quadratic fit, and the other using linear programming. 15 pp. Illus. Published in *The Journal of Chemical Physics*, May, 1958.

P-1060. A linear-programming approach to the chemical equilibrium problem.

G. B. Dantzig, S. M. Johnson, and W. B. White. 4-21-58. Unclassified.

An expression of the chemical equilibrium problem in the form of minimizing the free energy of a mixture to compute the chemical composition at equilibrium. By piece-wise linear approximations to the free energy function, the problem becomes a linear program which can be solved by a standard code on a computing machine. Successive approximations give any degree of accuracy. 11 pp. Illus. Published in *Management Science*, October, 1958.

● **P-1061-RC. Comments prepared for annual meeting of the Association for Asian Studies, panel discussion of economic development in South Asia.** Shera-ton-Plaza, Boston, April 3, 1957. Charles Wolf, Jr. 4-15-57. Unclassified.

A discourse on two papers presented before the Association for Asian Studies at Boston, Massachusetts, April 3, 1957. Part I deals with Malenbaum's paper on the significant relationships between economic and political factors in India's development. Part II discusses Higgins' paper on the Philippine economy and society and his comparison of the Philippines with Indonesia. 14 pp.

P-1062. The theory of games. R. E. Bellman. 4-15-57. Unclassified.

A discourse on the fundamental ideas of the theory of games and on the unresolved aspects of the theory. In particular, the author discusses coin-matching, saddlepoints, general two-choice games, general finite games, computational algorithms, continuous games, non-zero-sum games, n -person games, poker, and games of survival. 21 pp. Published as a chapter in *Tree of Mathematics*, ed. by Glenn James, Digest Press, Pacoima, California, 1958. \$5.00.

P-1063. A tactical air game. D. R. Fulkerson and S. M. Johnson. 7-24-57. Unclassified.

A formulation of a discrete, linear model of a tactical air war as a multimove game. The symmetric case in which the attrition rates are the same for both sides is solved for both finite and infinite campaigns. 20 pp. A revision of RM-1171. Published in *Operations Research*, October, 1957.

- **P-1064. A briefing on a method of estimating spare part essentiality.** H. W. Karr. 4-17-57. Unclassified.

A presentation of a set of essentiality categories with examples which seem applicable to all tactical fighter bombers. The author discusses (1) the ways in which essentiality factors can be used, (2) various elements to be considered in estimating essentiality factors, (3) an experiment with psychometric scaling techniques, and (4) a rationale for assigning essentiality or shortage penalty factors to particular categories of items. 41 pp. Illus. Also published as RM-1890. Published in the *Naval Research Logistics Quarterly*, March 1958. Presented before the Long-range Logistics Discussion Group at RAND, February 14, 1957.

P-1065. On the non-negativity of Green's functions. R. E. Bellman. 4-18-57. Unclassified.

A proof of the non-negativity of Green's functions associated with certain classes of differential equations. 6 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 12, No. 3, 1957.

P-1066. A Markovian decision process. R. E. Bellman. 4-18-57. Unclassified.

A discussion of the asymptotic behavior of the sequence $\{f_N(i)\}$ generated by the nonlinear recurrence relation

$$f_N(i) = \max_q \left[b_i(q) + \sum_{j=1}^M a_{ij}(q) f_{N-1}(j) \right].$$

This problem arises in connection with an equipment replacement problem treated by S. E. Dreyfus in P-1045, *A Note on an Industrial Replacement Process*. 13 pp. Published in the *Journal of Mathematics and Mechanics*, September, 1957.

- **P-1067. A note on the numerical integration of a class of nonlinear hyperbolic differential equations.** R. E. Bellman, I. Cherry, and G. M. Wing. 4-22-57. Unclassified.

A method for numerically integrating a class of nonlinear hyperbolic partial differential equations which admit shocks. The equation $u_t = uu_x$ is discussed, and numerical results are given. 5 pp. Table. Also published as RM-2318. Published in the *Quarterly of Applied Mathematics*, October, 1958.

- **P-1068. A proposal for reducing the cost of logistics support.** J. W. Petersen and W. A. Steger. 4-23-57. Unclassified.

A study of the procurement of spare parts for the U.S. Air Force in an attempt to examine the central problem of spare parts procurement and the most economical solution to this problem. It is shown that (1) deferral of procurement is worthwhile for some items, (2) the savings indicated may be between thirty and sixty percent of the total cost of expensive items under the present supply system, and (3) the deferred procurement system does not result in a noticeable reduction of the effectiveness of the supply system if sufficient data are collected to make a substantially improved forecast of future consumption. 7 pp.

P-1069. Supersonic flow around blunt bodies. Hyman Serbin. 8-1-57. Unclassified.

A discussion of the need for more accurate aerodynamic theories to better understand the problems of supersonic flow around blunt bodies. The author characterizes his theory as a reformulation of the Newtonian theory on the basis of gas dynamics and finds that agreement between test data and theory is very satisfactory. 10 pp. Illus. See also RM-1713, RM-1772, P 930, and P-1172. Published in the *Journal of the Aeronautical Sciences*, January, 1958. Presented before the Institute of the Aeronautical Sciences at Los Angeles, California, April 23, 1957.

- **P-1070. A cyclic arrangement of n -tuples.** L. R. Ford, Jr. 4-23-57. Unclassified.

An attempt to determine a cyclic arrangement of r^n symbols, each chosen from the set $R = \{0, 1, \dots, r-1\}$, such that each ordered n -tuple from R^n is to be found once and only once as n consecutive elements in the cyclic arrangement. Part I presents an algorithm for accomplishing this and a proof. Part II discusses applications of this arrangement to a problem of imitating a binomial distribution for small samples. 5 pp.

- **P-1072. On the computational solution of dynamic-programming processes—I: on a tactical air-warfare model of Mengel.** R. E. Bellman and S. E. Dreyfus. 5-23-57. Unclassified.

The first of a series of papers concerned with the computational solution of dynamic programming processes. The functional-equation approach is used to treat a tactical air-warfare model that A. Mengel previously considered by means of classical variational techniques. 23 pp. Illus. Also published as RM-1745. Published in *Operations Research*, January–February, 1958.

- **P-1073-AEC. On the compressibilities of simple metals.** W. G. McMillan and A. L. Latter. 5-6-57. Unclassified.

A derivation of an isothermal equation of state from the coulomb virial theorem for "simple" metals consisting of imperturbable (i.e., invariant) kernels embedded in a uniform sea of valence (e.g., s) electrons. Comparison with experiment at room temperature gives good agreement for the alkali and alkaline earth metals, but is understandably erratic for other groups. The compressibility is simply related to the heat of formation of the normal gaseous ion kernel. 9 pp. Published in *The Journal of Chemical Physics*, July, 1958. Presented before a seminar at the University of California at Los Angeles, May 17, 1957.

- **P-1074. Simulation in RAND's System Research Laboratory.** R. L. Chapman. 4-30-57. Unclassified.

A speech presented before the Symposium on System Simulation at New York City, May 16–17, 1957, and published in the proceedings of the Symposium. The author discusses (1) the need, concepts, and approach of RAND's System Research Laboratory, (2) simulation techniques and their limitations, and (3) several applications of simulation and practical criteria for its use. 8 pp. Illus.

- **P-1075. Simulation in RAND's Logistics Systems Laboratory.** W. W. Haythorn. 4-30-57. Unclassified.

A continuation of P-1074. The present paper discusses (1) the need, concept, and underlying approach of simulation, (2) various techniques of simulation, (3) the scope of its applications and its limitations, and (4) the appropriate time for using simulation. 13 pp. Table. Presented before the Symposium on System Simulation at New York City, May 16–17, 1957, and published in the proceedings of the Symposium.

- **P-1076. The Soviet atomic power program: large or small?** Arnold Kramish. 5-1-57. Unclassified.

Data on the individual reactor stations in the USSR and on the probable actual magnitude of the Soviet nuclear power program. As numerical data have become such a potent force in the politics of the atom, the author warns that it is dangerous to use presently ambiguous Soviet information in determining their development in this area. 9 pp.

- **P-1077. The small sample distribution of $n\omega_n^2$.** A. W. Marshall. 5-2-57. Unclassified.

A discussion of the asymptotic distribution of the statistic

$$n\omega_n^2 = n \int_{-\infty}^{\infty} [S_n(x) - F(x)]^2 dF(x),$$

where $S_n(x)$ is the sample cumulative distribution function (CDF), and $F(x)$ the true CDF. Some values of the CDF's of $n\omega_n^2$ for $n = 1, 2$ and 3 are tabled. Convergence to the asymptotic distribution appears to be extremely rapid. 6 pp. Table. Published in *The Annals of Mathematical Statistics*, March, 1958.

- **P-1079. Construction of maximal dynamic flows in networks.** L. R. Ford, Jr., and D. R. Fulkerson. 5-7-57. Unclassified.

A description of an algorithm for solving the problem of finding a maximal dynamic flow through a network. A network is considered in which each link has associated with it two positive integers. It is assumed that some node of the network is a source for the commodity, another a sink, and the remaining may either transship the commodity immediately on receipt or hold for later shipment. 12 pp. Illus. Published in *Operations Research*, May-June 1958. Presented before the Operations Research Seminar at the Illinois Institute of Technology, Chicago, Illinois, June 13, 1957.

- **P-1080-RC. Economic problems of alliance.** M. W. Hoag. 5-8-57. Unclassified.

A consideration of how economic problems of alliance can be analyzed. Narrow tests of economic efficiency in military allocations are seen to be sharply restricted in applicability, while a broad formulation in terms of game theory avoids these restrictions at the overriding cost of unworkability. The traditional treatment of civilian trade problems is suggested as a workable compromise. In addition, the outstanding issues confronting any such treatment of burden-sharing problems and the choice of military means are given. 37 pp. A condensed version of this paper was published in *The Journal of Political Economy*, December, 1957.

- **P-1081. Functional equations in the theory of dynamic programming—VIII: the variation of Green's functions—one-dimensional case.** R. E. Bellman. 5-8-57. Unclassified.

A study of the functional equation technique of dynamic programming to determine the dependence of the Green's function of the equation $u'' + q(x)u = f(x)$, $u(a) = u(1) = 0$ upon the parameter a . 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September, 1957.

- **P-1082. On the determination of characteristic values for a class of Sturm-Liouville problems.** R. E. Bellman. 9-19-57. Unclassified.

A proof of some upper and lower bounds for the characteristic values of the Sturm-Liouville problem $u'' + \lambda a(x)u = 0$, $u(0) = u(1) = 0$. Methods are used which are distinct from either the usual comparison or variational techniques. 19 pp. Published in the *Illinois Journal of Mathematics*, December, 1958.

- **P-1083. Dynamic programming solution of allocation problems.** S. E. Dreyfus. 5-9-57. Unclassified.

A discussion of the solution of allocation problems by means of the functional equation technique of dynamic programming. Dynamic programming is applied to static problems where allocation of a resource or resources is made to a variety of independent activities at a particular time. The formulation and computational solution of a simplified model is considered and then generalized to a more complex model. Numerical results are attained for the second model by use of the Lagrange multiplier approach. 13 pp. Illus. Presented before the Operations Research Seminar at the Illinois Institute of Technology, Chicago, Illinois, June 13, 1957.

- **P-1084. On the variation of the Fredholm resolvent.** R. E. Bellman. 5-13-57. Unclassified.

A study of the dependence of the Fredholm resolvent upon the end-points of the interval. With the use of the same technique, a formula is derived due to Schiffer concerning the variation of a Green's function upon a parameter. 6 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 14, No. 3, 1959.

- **P-1085. Remarks on future wars.** N. C. Peterson. 5-14-57. Unclassified.

The text of a lecture prepared for a course conducted by the University of Wisconsin and presented May 31, 1957. The author discusses the strategic and military environments of parts of the world for the next ten years or more. Some of the characteristics and the relative likelihood of various kinds of wars in which the United States may become involved are suggested, together with useful directions for developing U.S. military forces and international policy in this period. 28 pp. See also P-889. Also presented before the Symposium on Aerial Targets at the Air Force Armament Center, Eglin Air Force Base, Florida, November 4, 1957.

P-1086. Multi-dimensional maximization and dynamic programming. R. E. Bellman. 5-14-57. Unclassified.

A discussion of various difficulties arising in multi-dimensional maximization problems and some of the special types of problems which can be treated by dynamic programming techniques. In addition, linear programming is considered. 17 pp. Published as a chapter in *Tree of Mathematics*, ed. by Glenn James, Digest Press, Pacoima, California, 1958. \$5.00.

P-1087. Space law bibliography. J. C. Hogan. 5-15-57. Unclassified.

A bibliography on recently published articles which apply (either directly or by analogy) to man's activities above the surface of the earth. The immediate problem is state sovereignty in the upper atmosphere. In addition, the long-range problem of a system of jurisprudence for activities in space is considered. 12 pp. Published in *The Journal of Air Law and Commerce*, Summer, 1956.

P-1088. Legal terminology for the upper regions of the atmosphere and for the space beyond the atmosphere. J. C. Hogan. 5-15-57. Unclassified.

A discourse on the need for a standard terminology in law for describing the upper regions of the atmosphere and the areas beyond. This need has arisen because of the variety of man-made objects which will soon be operating at high altitudes and which can be expected to present somewhat different legal problems depending upon the heights and speeds at which they fly. The author defines such terms as airspace, the upper regions of the earth's atmosphere, space, outer space, world space, territorial space, contiguous space, and terrestrial space. 26 pp. Published in *The American Journal of International Law*, April, 1957.

● **P-1089. Electron density distribution in a new model of the ionosphere.** H. K. Kallmann. 5-15-57. Unclassified.

An outline of the theoretical analysis which has led to a new model of the ionosphere. Results which have been obtained with this model are presented, and the theoretical results are compared with the direct observations obtained by means of rockets. 6 pp. Presented before a meeting (sponsored by the *Union Radio Scientifique Internationale* and The Institute of Radio Engineers) at Washington, D.C., May 23, 1957.

P-1090. Topological dynamics: a book review. R. E. Bellman. 5-20-57. Unclassified.

A book review of *Topological Dynamics* by Walter H. Gottschalk and Gustav A. Hedlund (published by the American Mathematical Society Colloquium Publications, Vol. XXXVI, Providence, R.I., 1955). The book summarizes the present state of the topology of dynamical systems and discusses an interesting application of the theory. 2 pp. Published in *Scripta Mathematica*, 1957.

P-1091. Atmospheric transport and close-in fallout of radioactive debris from atomic explosions. W. W. Kellogg. 8-26-57. Unclassified.

A statement before the Joint Committee on Atomic Energy of the Congress of the United States at its hearings in June, 1957. The discussion is limited to close-in fallout (that occurring during the first day or two after an atomic explosion and depositing radioactivity within a few hundred miles of ground zero). Methods of computing fallout patterns are discussed, and the dynamics of fallout—the time in which various parts of the pattern are filled out—are described. 40 pp. Illus. See R-309. Published under the title, "The Nature of Radioactive Fallout and Its Effects on Man," in the *Hearings before the Special Subcommittee on Radiation of the Joint Committee on Atomic Energy*, Congress of the United States, 85th Congress, 1st Session, May 27–29, 1957, and June 3–7, 1957, U.S. Government Printing Office, Washington, D.C., 1957.

● **P-1092. The worth of principles of war.** Bernard Brodie. 5-21-57. Unclassified.

A discussion of the evolution of the principles of war. These principles are first considered as a general body of knowledge and secondly, as a particular list of maxims. The author feels that the chief danger of the principles of war is that they often become religious dogmas, and he objects to slogans in that they introduce a rigidity of thought. 22 pp. Presented before the U.S. Army Command and General Staff College at Fort Leavenworth, Kansas, March 7, 1957.

P-1094. Soviet atomic blackmail and the North Atlantic Alliance. Hans Speier. 4-1-57. Unclassified.

Part of a broader investigation concerned with the politics of German rearmament. The paper discusses atomic blackmail as it applies to West Germany. While the Soviets can exploit the threat-

value of their atomic weapons against European members of NATO, a new balance of atomic power will be achieved when NATO members acquire their own effective atomic capability. The furtherance of Soviet policy by this type of threat is shown in connection with the recent Middle East crisis. 43 pp. Also published as RM-1837. Published in *World Politics*, April, 1957.

P-1095. Notes on matrix theory—XV: multiplicative inequalities obtained from additive inequalities. R. E. Bellman. 5-27-57. Unclassified.

A proof that multiplicative inequalities for the characteristic values of positive definite matrices can be obtained from additive inequalities. 5 pp. Published in the *American Mathematical Monthly*, November, 1958.

P-1096. A psychoanalytic interpretation of Woodrow Wilson: a book review. Bernard Brodie. 4-1-57. Unclassified.

A book review of *Woodrow Wilson and Colonel House: A Personality Study* by Alexander L. George and Juliette L. George. This book is a psychoanalytic study of the personality structure of Woodrow Wilson and discusses his relationship with Colonel E. M. House, a close advisor. The study describes the unfortunate climax of Wilson's career when he rejected the Paris Treaty with the League Covenant, thereby denouncing the League of Nations. 18 pp. Published in *World Politics*, April, 1957.

● **P-1097. Kronecker products and the second method of Lyapunov.** R. E. Bellman. 5-29-57. Unclassified.

A discussion of the second method used by Lyapunov to study the stability of the trivial solution of $dx/dt = Ax + f(x)$. This method leads to the problem of solving the matrix equation $AX + XA' = C$. It is shown that this question is related to Kronecker products and Kronecker sums, and the general problem of solving $AX + XB = C$ is resolved in this fashion. 9 pp. Published in *Mathematische Nachrichten*, May-August, 1959.

P-1098. Analytical approximations, volume XXII. C. Hastings, Jr., and E. Hastings. 5-29-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, and P-1033. 2 pp. See also P-1117, P-1184, P-1208, P-1217, P-1229, and P-1301.

P-1099. Regional science techniques applicable to regional planning. F. T. Moore and W. Isard. 6-4-57. Unclassified.

Part of a broader investigation concerned with the diverse regional science techniques applicable to regional planning. Although some of the more promising techniques are discussed, the input-output technique is emphasized. 12 pp. Published in the *Proceedings of the Second International Conference on Regional Planning and Development, Held at The Hague, July, 1957*. Presented before the International Seminar on Economic Development and Regional Planning at The Hague, Netherlands, July 1-6, 1957.

P-1100. The mathematics of military pay. A. C. Enthoven. 11-11-57. Unclassified.

A suggestion that Congress instruct the Services to follow a policy of maximizing military effectiveness within the limitations of the personnel budget. It is shown that the optimum allocation of funds can be determined by beginning with the current program and comparing the actual over-all effectiveness of the service with that which would result from slightly different allocations. The fact that the Services can already decide what they consider to be an optimum balance between different ranks, ages, and specialties indicates that this theory is possible. 30 pp. Table.

P-1101. Terminal control, time-lags, and dynamic programming. R. E. Bellman. 6-10-57. Unclassified.

A discussion of terminal control problems for linear processes. By a preliminary transformation, numerous problems can be treated by means of the functional equation approach of dynamic programming in terms of functions of many fewer dimensions. In particular, problems of this nature involving time-lags and other hereditary effects can now be treated by the functional equation technique. 5 pp. See also P-1133. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, October, 1957.

P-1102. On the principle of invariant imbedding and neutron transport theory—I: one-dimensional case. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 6-11-57. Unclassified.

An extension of P-996, which presents a new method of treating problems involving neutron multiplication by fission. The present paper considers not only a one-dimensional version of the reflection and transmission of neutrons, and the phenomenon of critical mass, but also the effects of fission capture, and forward and backward scattering. Some numerical results describing the distributions obtained from the solution of forty simultaneous nonlinear differential equations are also presented. 22 pp. Illus. See P-839, P-976, P-996, P-1252, P-1380, P-1390, P-1495, and T-63. Published in the *Journal of Mathematics and Mechanics*, March, 1958.

P-1103-RC. NATO deterrent vs. shield. M. W. Hoag. 6-13-57. Unclassified.

A support of General Norstad's appeal to maintain sizable land forces in Europe that disagrees with his contention that such forces complement strategic airpower effectively in total war. However, planning for limited war provides an incentive to retain and enlarge land forces with strategic airpower complementing them by serving as the ultimate enforcer of limitations. 29 pp. A condensed version of this paper was published in *Foreign Affairs*, January, 1958.

P-1104. The growth of China's scientific and technical manpower. F. C. Iklé. 4-24-57. Unclassified.

A study concerned primarily with the future capability of Communist China's educational system and with the expansion of its scientifically trained manpower. It is concluded that the Chinese Communists should not find it difficult to provide the technical manpower for the capital equipment they have accumulated, although there may be shortages in certain specialized skills or in geographical regions. 75 pp. Illus. Also published as RM-1893.

P-1105. The history, purpose and script of *Cogwheel*. R. L. Chapman and M. G. Weiner. 6-24-57. Unclassified.

A discussion of *Cogwheel*, a 30-minute, 16-mm sound motion picture of RAND's Systems Research Laboratory (established in 1951 to explore man's function in complex systems). The need and purpose of the film are explained, and the script of the movie is included. 36 pp.

P-1106. A German discussion of atomic weapons and the law. E. W. Schnitzer. 7-17-57. Unclassified.

A discussion of an article (which appeared in West Germany's *Frankfurter Allgemeine Zeitung*) on the relationship between atomic weapons and the law. The article discusses the law of airspace, the position of a single nation as a member of the larger international community, and the position of the individual within the national community. 9 pp.

● **P-1107. The graphical integration of the one-parameter model with terrain effects.** J. B. Knox. 6-25-57. Unclassified.

A development of the theory of the one-parameter model so that the dynamic equation at the p^* -level (that of nondivergence over flat terrain) includes the effects of terrain and may be readily integrated by graphical procedures. The model makes possible the quantitative forecasting of the movement of trough systems pertaining to the North American mountain barrier. 35 pp. Illus. See also P-1108. Presented before the American Meteorological Society at Omaha, Nebraska, October 8-10, 1957.

● **P-1108. A physical basis for forecasting the pressure and horizontal wind fields in the lower stratosphere.** J. B. Knox. 8-29-57. Unclassified.

A re-examination of the theory of the one-parameter model of the atmosphere. It is shown that a second level of nondivergence exists in regions of 100 mb to 50 mb. In addition, the possibility of using the one-parameter model to forecast the horizontal wind field is discussed. 14 pp. Illus. See also P-1107. Presented before the National Conference on the Upper Air of the American Meteorological Society at Omaha, Nebraska, October 8-10, 1957.

- P-1111. Some strategic implications of the nuclear revolution. Bernard Brodie. 5-14-57. Unclassified.

A discourse on such aspects of the nuclear revolution as its decisiveness, the effect of its development, and the employment of massive retaliation and graduated deterrence. The author concludes that we must follow a path of enlightened self-interest to avoid the piecemeal surrender of the things we value or the kind of a war that destroys them at once. 22 pp. Presented before the Institute of World Affairs at the University of Utah, Salt Lake City, May 14, 1957, and published in pamphlet form as *International Study, Paper No. 1*.

- P-1112. The optimization of nozzle area ratio for rockets operating in a vacuum. Martin Goldsmith. 6-26-57. Unclassified.

A linearized analytic approach to the problem of determining the optimum nozzle area ratio for rocket-powered vehicles operating at very high altitudes. Correct area ratio becomes more important as the ratio of nozzle weight to burnout weight increases. 13 pp. Illus. Also published as RM-1718. Published in *Jet Propulsion*, March, 1958.

- P-1113. Random walk, scattering, and invariant imbedding—I: one-dimensional discrete case. R. E. Bellman and R. E. Kalaba. 6-27-57. Unclassified.

A method of treating problems involving random walk processes, based upon the principle of invariant imbedding. Since scattering processes are often formulated in terms of random walk, a new method of treating scattering processes is used. In subsequent papers the same methodology will be applied to corresponding problems for multi-dimensional regions and to continuous versions. 8 pp. See supplement P-1614. See also P-1858 and P-2202. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, October, 1957.

- P-1114. A suggested computation for maximal multi-commodity network flows. L. R. Ford, Jr., and D. R. Fulkerson. 3-27-58. Unclassified.

A computation which uses the structure of one formulation of the multi-commodity problem within the framework of a simplex computation to determine maximal multi-commodity flows in networks. For this particular formulation, the number of variables is too large to be dealt with explicitly. The suggested computation treats nonbasic variables implicitly by replacing the pricing operation of the simplex method with several applications of a combinatorial algorithm for finding a shortest chain joining a pair of points in a network. 10 pp. Published in *Management Science*, October, 1958.

- P-1115. A linear diophantine problem. S. M. Johnson. 7-16-59. Unclassified.

A discussion of a relatively prime set of integers a_1, a_2, a_3 , in which is found the largest integer B not represented in the form $xa_1 + ya_2 + za_3$, for positive integers x, y, z . Several relations are thus developed. Further efforts in this direction may lead to applications in discrete linear programming. 19 pp. Published in the *Canadian Journal of Mathematics*, Vol. XII, No. 3, 1960.

- P-1117. Analytical approximations, volume XXIII. C. Hastings, Jr., and E. Hastings. 6-28-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, and P-1098. 2 pp. See also P-1184, P-1208, P-1217, P-1229, and P-1301.

- P-1118. Implications of nuclear weapons in total war. Bernard Brodie. 7-8-57. Unclassified.

Part of a broader investigation concerned with the general theory of air strategy in a nuclear age. This paper states that (1) an unrestricted strategic air campaign in a war in which the United States is engaged will be decisive, (2) strategic bombing will prove other kinds of military operations unfeasible, and (3) those surviving strategic attack will be far more important in the national recovery following hostilities than in controlling the subsequent course of the war. 34 pp. Also published as RM-1842. Published in the *Royal Canadian Air Force Staff College Journal*, 1957.

- P-1119. Recovery of a circum-lunar instrument carrier. C. Gazley, Jr., and D. J. Masson. 8-19-57. Unclassified.

A study of the physical recovery of a vehicle which has traveled around the moon. The recovery of cameras and other scientific instrumentation is shown to be feasible. The tracking during the

return and subsequent accurate location of the vehicle after impact on the earth, re-entry heating and deceleration, and nondestructive water impact are considered. 22 pp. Illus. Presented before the International Astronautical Federation at Barcelona, Spain, October 12, 1957.

P-1121. Ionospheric electric-current systems derived using International Polar Year data. E. H. Vestine and T. Nagata. 10-1-57. Unclassified.

A summary of the present state of knowledge of the electric-current systems flowing within the upper atmosphere. The authors discuss the contributions to the knowledge of electric-current systems made since 1880, particularly the contributions based on data derived during the Second International Polar Year (1932-1933). 41 pp. Illus. Published in the *Annals of the International Geophysical Year, Vol. I*, ed. by Sir Harold Spencer-Jones, Pergamon Press, London, England, 1958. \$17.00.

● **P-1122. Linear programming and structural design—I: limit analysis.** William Prager. 7-1-57. Unclassified.

A discussion of limit analysis, which provides the structural engineer with a realistic estimate of the load-carrying capacities of structures made of ductile materials. The problem of limit analysis is one of linear programming, and a method of solution (essentially the simplex method with prices) is determined. 17 pp. Illus. See Part II, P-1123.

● **P-1123. Linear programming and structural design—II: limit design.** William Prager. 7-11-57. Unclassified.

A discussion of limit design, which guides the structural engineer toward an economic design of structures that are made of ductile materials and have to carry specified loads. The problem can be reduced to one in linear programming, and a method of solution is discussed that has been found efficient for structures of moderate complexity. In addition, a sketch of the historical development of limit analysis and design is given. 27 pp. Illus. See Part I, P-1122.

P-1124. Comparison of American rotary electric desk calculators. F. J. Gruenberger. 7-15-57. Unclassified.

A comparison of the current comparable models of the Friden, Marchant, and Monroe desk calculators. The advantages and disadvantages of these models are listed, and those features which tend to make the machines noninterchangeable are discussed. The survey was conducted with the cooperation of the local salesmen of the three firms. 17 pp. Published in *Computing News*, November 1, 1957.

P-1125. On the representation of the solution of a class of stochastic differential equations. R. E. Bellman. 7-9-57. Unclassified.

A discussion of a representation of the distribution function of the solution of the stochastic differential equation $u' = g(u) + r(t)$. It is assumed that $r(t)$ is a given stochastic function, and $g(u)$ is either strictly convex or strictly concave for all u . Extensions of this result to more general types of nonlinear functional equations may be readily obtained, following the techniques given in P-704, *Functional Equations in the Theory of Dynamic Programming—V: Positivity and Quasilinearity*. 4 pp. Published in the *Proceedings of the American Mathematical Society*, April, 1958.

P-1126. Scattering of light by protons. W. J. Karzas, K. M. Watson, and F. Zachariasen. 11-11-57. Unclassified.

An analysis of the scattering of photons from a nucleon within the framework of the Chew-Low-Wick development. It is shown that an exact relationship exists between the Compton Effect amplitude and the experimental meson-nucleon scattering phase shifts for all multipoles except magnetic dipole and electric quadrupole. The effects arising from currents inside the nucleon source are assumed to be slowly varying functions of photon energy. 32 pp. Illus. Published in *The Physical Review*, April 1, 1958.

P-1127. Intellectual unrest behind the Iron Curtain. Paul Kecskemeti. 7-11-57. Unclassified.

A discourse on the political background and significance of the recent ferment among the intellectuals behind the Iron Curtain. The Polish and Hungarian confessional writings as well as the nonconformist works of Russian writers attack the party apparatus in the name of the party in-

telligentsia. In discussing the effect of this attack, the author concludes that desertion of the party intelligentsia does not necessarily mean the end of the party bureaucracy's power but that it has rendered it less secure. 20 pp. Published in *Commentary*, November, 1957.

- P-1132. The casino that takes a percentage and what you can do about it. L. J. Savage. 10-17-57. Unclassified.

A discussion of how a gambler operating under constraints should behave to maximize the admittedly small probability of running a small sum up to a large one. It is concluded that if the casino's cut is at least 100%, then the probability of running a fortune up to t times its original value is less than $1 - [(t-1)/t]^{1-\gamma}$. However, it can sometimes be nearly that much. 15 pp.

- P-1133. Dynamic programming, nonlinear variational processes, and successive approximations. R. E. Bellman. 9-6-57. Unclassified.

An attempt to show that dynamic programming, combined with successive approximations and digital computers, aids in solving various classes of nonlinear variational problems. The problem considered is that of determining the minimum of a functional of the form

$$J(v) = \int_0^T F[x_1(t), \dots, x_N(t)] dt + G[x_1(T), \dots, x_N(T)],$$

over all forcing functions $v_i(t)$ subject to certain relations. 7 pp. See also P-1101. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, June, 1958.

- P-1134. International registration of the atom. Arnold Kramish. 7-26-57. Unclassified.

A suggestion that all nuclear activities be registered independently and in advance of any disarmament agreement to achieve a disciplined manufacture and use of armaments. The need to understand the potential of nuclear armament is emphasized. The author concludes that political forces, properly backed by reasoned knowledge of the atomic nucleus, may avert atomic destruction. 9 pp.

- P-1135. Khrushchev and the political crisis of June 1957. Myron Rush. 7-23-57. Unclassified.

A study of Khrushchev's bid for power since Stalin's death, and particularly since January, 1955. The June days of 1957 were the climax of the developing crisis within the collective leadership which was brought on by Khrushchev's efforts to establish his hegemony over party and country. The outcome of these events not only demonstrated the high degree of power already possessed by Khrushchev, but added immeasurably to it. It is concluded that should Khrushchev prove unable to cope with the serious problems he now faces, a new succession crisis might arise. 53 pp. Also published as RM-1947. A continuation of RM-1883. See condensed version P-1146. See also RM-2441. Incorporated in *The Rise of Khrushchev*, Public Affairs Press, Washington, D.C., 1958. \$3.25.

- P-1136. Factor productivity and economic growth. Charles Wolf, Jr. 8-1-57. Unclassified.

A discussion of the causes of rising factor productivity. Two alternative hypotheses are offered to account for increases in output due to technological change. The hypothesized explanatory variables in the "technology function" are educational expenditures and the average propensity to save. 16 pp. Table. Published in the *Proceedings of the Western Economic Association*, 1957. Presented before the Western Economic Association at the University of Utah, Salt Lake City, August 30, 1957.

- P-1138. Intercontinental military air transport: an application of a model for the study of aircraft procurement policies. C. B. McGuire. 8-30-57. Unclassified.

An application of a mathematical model to determine aircraft procurement policies. Wartime airlift requirements, worldwide route structure, and the physical characteristics of candidate intercontinental transport aircraft are considered. The model permits the construction of several efficient fleet replacement patterns, each consistent with aircraft production possibilities and the fleet in being. Costs based on procurement and peacetime practice operations are used to yield partial evaluations of the alternative procurement policies that result. 55 pp. Illus. Incorporated in *The Economics of Defense in the Nuclear Age*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$9.50.

P-1139. Dynamic programming and the reliability of multicomponent devices. R. E. Bellman and S. E. Dreyfus. 7-31-57. Unclassified.

A proof that the functional-equation technique of dynamic programming may be used to treat a class of problems which arises in constructing multicomponent devices. An attempt is made to determine the types of components and the quantities to be used in constructing the most reliable device possible subject to given cost and weight constraints. A numerical example is given. 13 pp. Illus. See revised version RM-2245. Published in *Operations Research*, April, 1958.

P-1140-RC. A commentary on fire research. J. C. DeHaven. 7-24-57. Unclassified.

An account of the Mass Fire Study Group Conference, jointly sponsored by the National Academy of Sciences and The University of California at Los Angeles, May 26-28, 1957. Research is suggested based on the description of hostile fires presented by the practical fire fighters. In addition, the application of operations research to problems of fire fighting is discussed. 13 pp. Incorporated in the *Report on the Second Fire Research Correlation Conference*, National Academy of Sciences, Washington, D.C., September 1957.

• **P-1141. The complete solution for an elastic half-space under a point step load.** H. A. Lang. 10-23-57. Unclassified.

A continuation of the problem of the dynamic response of an elastic half-space to a unit step load by extending a method developed earlier by the author to include the phenomena of total reflection and Rayleigh surface waves. The method is confirmed, and a complete solution of the problem is given. 34 pp. Illus. See also P-832 and P-1173.

P-1142. Forces for change in Soviet society. R. C. Tucker. 1-25-56. Unclassified.

A presentation of some tentative conclusions of recent research on trends of Soviet society and leadership since the death of Stalin. The reasons examined for the changes expected in the Soviet Union are (1) the failure of the population to respond to the goals of the Soviet state and (2) a restiveness of the managerial class, which was so long kept impotent while Stalin was alive. 58 pp. Also published as RM-1636.

P-1143. Certain fundamental approaches to the use of biological material in space devices. Irwin Cooper. 12-4-57. Unclassified.

An examination of the concept of using biological material in space vehicles. The basic relationship between structure and function in animal and plant cells is used to observe what metabolic process in a living equilibrium may be effectively monitored to determine the fate of the cell(s) during space travel. 26 pp. Illus. Presented before the American Rocket Society at New York City, December 4, 1957.

• **P-1144. Deterrence.** Olaf Helmer. 3-11-57. Unclassified.

A discourse on the issues involved in deterrence. Such topics are considered as retaliatory capability and intentions, war plan assumptions, peripheral deterrence, and deterrence strategy. 8 pp. Also published as RM-1882.

P-1145. Digital computer programming: a book review. C. L. Baker. 8-5-57. Unclassified.

A review of *Digital Computer Programming* by D. D. McCracken which discusses the problems of coding for a high-speed stored program computer. The book is commented upon chapter by chapter, and its general philosophy is examined. It is concluded that *Digital Computer Programming* will undoubtedly be the standard text on coding for some time to come. 18 pp. Published in *Mathematical Tables and Other Aids to Computation*, October, 1957.

P-1146. Khrushchev as senior secretary: his rise and his ambitions. Myron Rush. 8-16-57. Unclassified.

A discourse on the successful attempt of Khrushchev to subvert collective leadership, magnify his authority as senior secretary, and establish himself, by means of this office, as Stalin's rightful successor. His goal was achieved in the political crisis of June, 1957, when his designs over the top party organs were realized. 13 pp. A condensed version of P-1135. See also RM-1883 and RM-1947. Incorporated in *The Rise of Khrushchev*, Public Affairs Press, Washington, D.C., 1958. \$3.25.

- **P-1147. Dynamic programming and mean square deviation.** R. E. Bellman. 9-13-57. Unclassified.

An application of the functional equation technique of dynamic programming to the treatment of some quadratic variational problems and linear equations. The author attempts (1) to determine the minimum value of the quadratic deviation

$$\int_0^T \left(f - \sum_{k=1}^N x_k \phi_k \right)^2 dx,$$

where $f(x)$ is a given function of $[\phi_k(x)]$, a given sequence of real functions; (2) to minimize the quadratic form

$$Q_{N,M}(x) = \sum_{k=0}^N \left(b_k - \sum_{l=0}^M x_l a_{k-l} \right)^2$$

over all real x_i , where $[a_k]$ and $[b_k]$ are given real sequences; and (3) to discuss the problem of solving the linear system $Ax = b$, under the assumption that A is positive definite. 12 pp.

- P-1148. Some new techniques in the dynamic-programming solution of variational problems.** R. E. Bellman. 8-6-57. Unclassified.

An attempt to overcome some difficulties in solving a large class of variational problems in which the underlying equations and the criterion function are linear, although the restraints on the forcing functions may be nonlinear. It is indicated how the method of successive approximations may be combined with the techniques mentioned to reduce general variational problems, in which the equations and criterion function are nonlinear, to sequences of problems which can be solved numerically by sequences of functions of one variable. 21 pp. Published in the *Quarterly of Applied Mathematics*, October, 1958.

- P-1149. The structural exploitation of the strength of "whiskers."** G. A. Hoffman. 8-6-57. Unclassified.

A study dealing with the possible exploitation of the phenomenal strengths of fine crystalline filaments ("whiskers") for structural purposes. The structural properties of least-weight hypothetical materials are calculated and used in comparing the weights of equal-strength tension structures of whiskers and conventional materials. Weight reductions to one-fifth appear possible. 29 pp. Illus. Published in *Astronautics*, August, 1958, and in the *Journal of Metals*, September, 1958.

- P-1150. Dynamic programming and the variation of Green's functions.** R. E. Bellman and H. A. Osborn. 8-6-57. Unclassified.

An application of the functional equation technique of dynamic programming to the study of quadratic functionals whose Euler variational equations are linear self-adjoint partial differential equations of the second order. A first consequence is the classical Hadamard variational formula for the Green's function of a region. Some extensions are indicated. 8 pp. Published in the *Journal of Mathematics and Mechanics*, January, 1958.

- P-1151. A multimove infinite game with linear payoff.** L. D. Berkovitz and M. Dresher. 9-22-58. Unclassified.

An analysis of a multimove infinite game with linear-payoff function. The game is symmetric in every respect except for the initial conditions of the two players, which are different. On each move, each player allocates his resources to tasks of attacking, defending, and scoring. His resources for the next move are diminished by the amount that his opponent's attack exceeds his own defense, while his score cumulates from move to move. The game value and the optimal strategies for the players are derived. It is shown that one player has a pure optimal strategy and that the other player must randomize. 52 pp. Illus. Published in the *Pacific Journal of Mathematics*, Fall 1960. Presented before the Game Theory Symposium at the University of California at Los Angeles, November 15, 1957.

- **P-1152. On the estimation of the Kloosterman sum.** D. R. Anderson. 8-7-57. Unclassified.

A study of the Kloosterman sum $K(m_1, m_2; n)$ in the case where n is a prime. An estimate is obtained by using a method of Mordell to express the sum in terms of contour integrals which are in turn put into an accessible form by analytic continuation and use of the Mellin transform.

117 pp. Presented before the American Mathematical Society at Pennsylvania State University, University Park, Pennsylvania, August, 1957.

P-1153. On the non-negativity of solutions of the heat equation. R. E. Bellman. 8-12-57. Unclassified.

A proof that the non-negativity of the solution of the heat equation can be established quite readily once the existence of a solution of the equation depending continuously upon the initial values has been demonstrated. It is shown that (1) this property is trivially true for the solution of the appropriate finite difference approximation to the partial differential equation and (2) the convergence of the solution of the finite difference equation to the solution of the original equation is quite simple, under the conditions stated. 6 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 12, No. 3, 1957.

P-1154. Do disparities between real and money prices modify traditional arguments for freer trade? Stephen Enke. 8-15-57. Unclassified.

A discourse on the effect of disparities between real and money prices on traditional arguments for freer trade. The author concludes that (1) from the selfish viewpoint of a single country, the existence of discrepancies abroad between money and real costs and gains in no way modifies traditional arguments for free trade, and (2) import restrictions are not usually appropriate for a country like the U.S. when real values and money prices are disproportionate at home. 43 pp. Illus. Published in the *Foreign Trade Policy Compendium of Papers on United States Foreign Trade Policy, Collected by the Staff for the Subcommittee on Foreign Trade Policy of the Committee on Ways and Means*, U.S. House of Representatives, U.S. Government Printing Office, Washington, D.C., September, 1957.

P-1155. Dynamic programming and the computational solution of feedback design control problems. R. E. Bellman. 8-15-57. Unclassified.

An attempt to indicate how a certain class of control processes can be reduced to problems involving sequences of functions of one variable in a number of cases, and sequences of functions of two variables in others. The results of this paper may serve as a guide to a systematic study of nonlinear control processes, with or without time-lags and other types of hereditary behavior, by way of the method of successive approximations. 24 pp. Illus. Published in the *Proceedings of the Computers in Control Systems Conference*, October, 1957. Presented before the American Institute of Industrial Engineers at Atlantic City, New Jersey, October 16-18, 1957.

● **P-1156. General equilibrium for linear models. David Gale. 8-15-57. Unclassified.**

A study of the price equilibrium for models of pure exchange in which the preferences of the consumers are given by linear utility functions. Not only is a simple irreducibility condition shown to be sufficient for the existence of equilibrium, but also this equilibrium is shown to be essentially unique. A simple dynamic mechanism, believed to converge to an equilibrium, is proposed, and the bargaining model of Nash and the problem of aggregating utility functions are treated. 31 pp. Presented before the Econometric Society at Atlantic City, New Jersey, September 12, 1957.

P-1157. A new model of the atmosphere and ionosphere. H. K. Kallmann. 8-19-57. Unclassified.

A presentation of a new model of the atmosphere, incorporating results of recent rocket observations of atmospheric properties at high altitudes. It is emphasized that as this theoretical study is still very complex and involves numerous uncertainties, further changes in the present picture of the ionosphere can be expected. 7 pp. Illus. Published in the *Annales de Géophysique*, April-June 1958. Presented before the Union for Geodesy and Geophysics at Toronto, Canada, September 4-14, 1957.

● **P-1158. An isoquant approach to investment decision problems. Jack Hirshleifer. 8-23-57. Unclassified.**

An attempt to solve, through the use of isoquant analysis, the problem of optimal investment decisions. The principles stated in Irving Fisher's *The Theory of Interest* are reviewed in connection with the rules of behavior currently proposed by economists to guide business-investment decisions. The author concludes that (1) the Present-value Rule for investment decisions is universally correct, but in a limited sense, and (2) the Internal-rate-of-return Rule for the multi-period case is not

generally correct, if the usual definition of the internal rate is adopted. 45 pp. Illus. Published under the title "On the Theory of Optimal Investment Decision" in *The Journal of Political Economy*, August, 1958.

P-1159. Economic problems in Air Force logistics. Horst Mendershausen. 2-4-58. Unclassified.

A discourse on the infusion of economic concepts and methodology into military logistics for handling complex problems and for developing a more rational use of human and material resources. To economists the military field offers a new area of application and opportunities for developing techniques that may prove to be valuable in other fields. The author suggests that some day economics may even contribute to integrating the services by giving them common concepts to help them deal with their logistics problems. 24 pp. Illus. Published in *The American Economic Review*, September, 1958.

P-1160. Statistical decision theory as a guide to information processing. H. M. Wagner. 8-26-57. Unclassified.

A suggestion that the statistical-decision-theory approach be applied to data-processing problems concerned with decision-making in the face of uncertainty. The decision-theory technique automatically weighs the different economic considerations involved in taking action and gathering data. In addition, several drawbacks to this approach are considered. 28 pp. Illus. Published in *The Journal of Industrial Engineering*, January-February, 1959. Presented before the Massachusetts Institute of Technology at Cambridge, Massachusetts, July 15, 1957.

P-1163. On nonlinear differential equations, the maximum operation, and monotone convergence. R. E. Kalaba. 11-1-57. Unclassified.

A proof that the solutions to certain classes of nonlinear ordinary and partial differential equations may be represented in terms of the maximum operation applied to the solutions of associated linear equations. This, in effect, affords a new approach to the quasi-linearization of nonlinear differential equations. The representation readily yields uniform lower bounds for solutions, and, in the case of stochastic nonlinear differential equations, leads to representations for the distribution functions of the solutions. In addition, a technique is provided for constructing monotone sequences of functions which converge quadratically to the solution of the nonlinear equation, which is of value in machine computation. 98 pp. Tables. See also P-2210. Published in the *Journal of Mathematics and Mechanics*, July, 1959.

● **P-1164. The existence of conservation laws—I.** Howard Osborn. 9-3-57. Unclassified.

A study concerned with certain linear transformations of the Pfaffian forms at each point of a neighborhood of an analytic manifold. A construction is given of all the locally exact forms whose images are also locally exact. 27 pp. Published in the *Annals of Mathematics*, January, 1959.

P-1165. Monte Carlo. H. Kahn and I. Mann. 7-30-57. Unclassified.

A draft of Chapter IX of a proposed book, *Military Planning in an Uncertain World*. This paper discusses how to increase the efficiency of a Monte Carlo calculation by proper experimental design. The techniques described for reducing variance are importance sampling, Russian roulette and splitting, use of expected values, correlation and regression, systematic and stratified sampling, and specialized techniques. 28 pp.

P-1166. Game theory. H. Kahn and I. Mann. 7-30-57. Unclassified.

A section of a proposed book on military planning in an uncertain world. The present paper discusses game theory, defined as a study of games and of any conflict situation. In particular, conflict situations are investigated where there are two or more participants who do not have identical objectives. Two-person, non-zero-sum games and n -person games are examined, together with other theorems and examples. 65 pp. Illus.

P-1167. War gaming. H. Kahn and I. Mann. 7-30-57. Unclassified.

A draft of Chapter XI of a proposed book, *Military Planning in an Uncertain World*. The levels of war gaming discussed are (1) the informal game, an attempt to determine the enemy's reactions; (2) rule games, designed to abstract from the real world a fairly definite set of rules which all players must observe; (3) the formal minimum rule game which investigates the sensible rules of play; and (4) realistic war games where maneuvers and training exercises are tested in a realistic environment or in realistic contexts. 14 pp.

P-1169-RC. Does efficient peak-load pricing involve discrimination? Jack Hirshleifer. 9-9-57. Unclassified.

A commentary on P. O. Steiner's article, "Peak Loads and Efficient Pricing." The author of the present paper agrees with Steiner's solution of the problem of peak-load efficient pricing, but disagrees with his statement that the solution involves discriminatory prices. It is shown that the efficient price differences in a peak-load situation are not discriminatory because they are equal to the differences in the marginal cost of serving the classes of customers involved. 12 pp. Illus. Published under the title "Peak Load and Efficient Pricing: Comment" in *The Quarterly Journal of Economics*, August, 1958.

P-1170. Israel's national expenditure: summary of results. Harold Lubell. 9-9-57. Unclassified.

A summary chapter for a report entitled *Israel's National Expenditure, 1950-1954* (published by the Falk Project for Economic Research, Jerusalem, Israel, 1958. \$2.00). The national expenditure figures presented show the development, during this period, of the level of national welfare and the allocation of national resources. A summary breakdown of Israel's expenditures on gross national product is given, in current and constant (1952) prices. 48 pp. Tables.

P-1171. The maser: a new-type molecular amplifier for microwave radiation. W. H. Culver. 10-18-57. Unclassified.

A description of the maser, a device now being developed that amplifies electrical signals by the stimulated emission of radiation instead of by the use of charged particle motions in electric or magnetic fields. The author presents the historical development of the maser, its principle of operation, and some examples of its various types. 20 pp. Illus. Published in *Science*, October 25, 1957.

P-1172. The high-speed flow of gas around blunt bodies. Hyman Serbin. 9-11-57. Unclassified.

A synthesis of results previously derived by the author on the flow of air around blunt bodies moving at high speeds. The theory predicts satisfactorily the shock shape and detachment distance for two blunt bodies, a flat disk, and a sphere. It is shown that the density ratio across a normal shock is a useful parameter combining the effects of both the free-stream Mach number and the ratio of specific heats. 37 pp. Illus. See also RM-1713, RM-1772, P-930, and P-1069. Published in *The Aeronautical Quarterly*, November, 1958.

• **P-1173. Progress report on axisymmetric wave fields.** H. A. Lang. 8-20-57. Unclassified.

A review of recent wave-propagation studies in an elastic half-space. This paper outlines future-planned studies and exhibits completed results given in greater detail in P-832 and P-1141. 15 pp. Illus. Presented before the Second Hypervelocity and Impact Effects Symposium, sponsored by the Air Research and Development Command and the Naval Research Laboratory, at Washington, D.C., May 23, 1957, and published in the proceedings of the Symposium.

• **P-1174. Experimentation by simulation and Monte Carlo.** A. W. Marshall. 1-28-58. Unclassified.

A discussion of simulation and Monte Carlo as modes of analysis of particular interest in problems of operations analysis involving many variables. After defining these terms, the author considers Monte Carlo design when simulation aspects are not emphasized and simulation design with Monte Carlo aspects. 14 pp. Presented before the Third Conference on the Design of Experiments in Army Research, Development, and Testing at Washington, D.C., October 16, 1957, and published in the proceedings of the Conference (Report No. 58-5).

P-1175. Dynamic programming, successive approximations, and variational problems of combinatorial nature. R. E. Bellman. 9-13-57. Unclassified.

An attempt to show that a combination of dynamic programming and the classical method of successive approximations permits a systematic study of various classes of combinatorial problems arising in scheduling, communication, and network theory. Examples are the Hitchcock-Koopmans transportation problem, an allocation problem, and the travelling-salesman problem. 7 pp.

- **P-1176. Functional approximations and dynamic programming.** R. E. Bellman and S. E. Dreyfus. 4-28-59. Unclassified.

Ways in which the theory of approximation can be used to increase the range of present-day computers. An attempt is made to trade additional computing time, which is expensive, for additional memory capacity, which does not exist. Although primary interest is in applying these techniques to the functional equations occurring in dynamic programming theory, the same methods are applicable to the classical functional equations of mathematical physics. 12 pp. Published in *Mathematical Tables and Other Aids to Computation*, October, 1959.

- **P-1178. An airborne collision-warning device.** J. L. Jenkins. 11-11-57. Unclassified.
A proposal of a simplified airborne collision-warning device that relies primarily on determining altitude separation to provide detection of impending collision. The cooperative system is offered as an interim solution to the problem of collision warning. It is suggested that the system is justified because of its relatively low cost, weight, and early availability. 18 pp. Illus.

- **P-1179. An economist looks at Air Force logistics.** Stephen Enke. 9-17-57. Unclassified.

An attempt to recruit and orient economists by explaining Air Force logistics in understandable terms. Such topics are considered as the size and scope of Air Force support of its bases, the base production function, the base parts supply function, the requisitioning cycle, some procurement alternatives, and the general interdependence of the logistics system. 30 pp. Illus. Published in *The Review of Economics and Statistics*, August, 1958.

- **P-1180-RC. Criteria of efficiency in government expenditures.** R. N. McKean. 9-18-57. Unclassified.

A discussion of the criteria problems involved in choosing efficient government programs. The inevitability of breaking problems into administratively manageable subproblems and the consequent danger of applying inconsistent criteria are explained. Common criteria errors and how they can be guarded against are discussed. 12 pp. Illus. Published in the *Federal Expenditure Policy for Economic Growth and Stability*, Joint Economic Committee, Congress of the United States, 85th Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., November 5, 1957. \$3.25. Presented to the Subcommittee on Fiscal Policy, Joint Economic Committee, U.S. Congress, Autumn, 1957.

- **P-1181. Efficient transportation and industrial location.** T. A. Goldman. 1-28-58. Unclassified.

A discussion of a linear programming model to minimize the transportation requirement for a given program of steel consumption at three respective locations. It is assumed that the number of raw materials in the production activity is equal to the number of locations and that each location produces only one raw material. The dependence of the solution (in terms of the vector of activity levels and the associated vector of efficiency prices) upon the parameters of demand, input coefficients, and distances, is the end-product of the model. 25 pp. Tables. Presented before the Regional Science Association at Philadelphia, Pennsylvania, December 27-28, 1957.

- **P-1182. Concepts of cost for use in studies of effectiveness.** David Novick. 10-4-57. Unclassified.

A paper primarily concerned with weapon system cost. The author discusses the fixed-budget case, the fixed-effectiveness case, the role that cost and weapons systems effectiveness plays in the total weapon systems analysis picture, the importance of cost as a measure of effectiveness, and the accuracy in cost measurements. 14 pp. Illus. Presented before the Operations Research Society of America at San Francisco, California, September 27, 1957.

- **P-1183. "Contradictions" in the Moscow-Peking axis.** A. S. Whiting. 9-24-57. Unclassified.

An examination of the military, economic, and ideological interaction between the Soviet Union and the People's Republic of China from 1955 to 1957. Placed against the first 5 years of the Sino-Soviet alliance, trends of changing relationships caused by Stalin's death and the Korean armistice are projected for probable developments in the near future. The military, economic, and ideological factors discussed operate within the confines of the alliance in terms of the relative

positions of the partners vis-à-vis each other. In addition, they exist in a world situation as viewed from Peking and Moscow, juxtaposing the position of the partners against their perceived opponents. 61 pp. Also published as RM-1992. Published in the *Journal of Politics*, February, 1958.

P-1184. Analytical approximations, volume XXIV. C. Hastings, Jr., and E. Hastings. 9-27-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, and P-1117. 2 pp. See also P-1208, P-1217, P-1229, and P-1301.

- **P-1185. A method of computing the inherent accuracy with which a time delay can be estimated.** Peter Swerling. 9-27-57. Unclassified.

An approach to the problem of calculating the limits of accuracy with which a time delay between transmission and reception of a waveform can be estimated. After a summary of requisite results from the theory of statistical estimation, certain functions are evaluated which are necessary for applying estimation theory to the case of time-delay estimation; the advantages of this method are discussed. 21 pp. See also P-1221 and P-1247. Presented before the Professional Group on Information Theory of the Institute of Radio Engineers at Los Angeles, California, April 17, 1958.

P-1186. Supply and demand and military pay. A. C. Enthoven. 9-30-57. Unclassified.

A study of the economic aspects of recent proposals to increase military salaries. The author argues that more military effectiveness could be obtained if more money were spent on hiring scarce technicians and correspondingly less on unskilled manpower, and, further, that more effectiveness could be obtained, with no increase in the total military budget, if more were spent on personnel and less on equipment. 14 pp. Published as "An Economist's View of the Cordiner Recommendations" in *Air Force*, January, 1958.

- **P-1187. Fuel cells: current problems and potential usefulness.** J. H. Huth. 9-27-57. Unclassified.

A study of the mode of operational problems and potential applications of fuel cells. These cells are defined as devices in which a fuel, usually in gaseous form, is oxidized electrochemically to produce electrical energy directly. The cells are at least an order of magnitude lighter than lead-acid storage batteries (for cases in which feed-gas weight predominates) and may be potentially useful as accumulators of solar energy. 23 pp. Illus. Prepared for a course on the utilization of solar energy, given at the University of California at Los Angeles, Fall, 1957.

- **P-1188. A feasibility criterion for staircase transportation problems and an application to a scheduling problem.** D. R. Fulkerson. 10-2-57. Unclassified.

A proof that a feasibility criterion for transportation problems in which certain variables are inadmissible yields a simple feasibility test for such problems when the admissible set has the form of a staircase. A rule is presented for singling out a feasible solution for staircase problems. As an application of these results, it is shown that a particular case of the problem of minimizing the number of carriers to meet a fixed schedule can be solved explicitly by an appropriate interpretation of the staircase rule. 17 pp. Illus.

- **P-1189. Thin airfoils in hypersonic flow with strong shocks.** J. L. Raymond. 12-19-57. Unclassified.

A derivation, in closed form, of the expression for normal force for the case of hypersonic flow with strong shocks. The present expression is derived from a simple relation between the two-dimensional pressure coefficients for shocks and expansion flows. Although this relationship is based on small-disturbance theory, the force calculations appear to agree with "exact" shock-expansion theory and with experiment to angles of attack of 25 deg. 20 pp. Illus. Published in the *Journal of Fluid Mechanics*, August 1960.

P-1190. Theory of the solar aureole—part I: scattering and radiative transfer. Diran Deirmendjian. 10-3-57. Unclassified.

A discussion of a theory of the clear-sky aureole around the sun as a problem of radiative transfer in a plane-parallel scattering atmosphere. Applications of the theory to the sky light in the immediate vicinity of the sun will be discussed in a future paper. 40 pp. Illus. Also published as RM-2008. Published in the *Annales de Géophysique*, October–December 1957.

P-1191. Dynamic problems in the theory of the firm. H. M. Wagner and T. M. Whitin. 10-4-57. Unclassified.

An extension of the "theory of the firm" to dynamic deterministic situations. In particular, a method is discussed for obtaining the optimal time profile of production and sales for a firm facing known demand and cost schedules over n periods. Demand is assumed to be a function of the price charged during the period, and costs include direct manufacturing expenses, inventory holding charges, and fixed or set-up costs incurred when period production occurs. This paper attempts to frame and solve the problem in terms and with techniques familiar to most economists. 36 pp. Illus. Published in the *Naval Research Logistics Quarterly*, March, 1958, and as Appendix G in *The Theory of Inventory Management* (second edition) by T. M. Whitin, Princeton University Press, Princeton, New Jersey, 1957. \$4.50. Presented before the Econometric Society at Atlantic City, New Jersey, September 13, 1957, and before the Operations Research Society at Boston, Massachusetts, May 15, 1958.

- **P-1192. A new approach to the Kolmogorov-Smirnov distributions.** D. A. Darling. 10-4-57. Unclassified.

A theory for calculating the Kolmogorov-Smirnov distributions, which is based on a combination of (1) the observation that the empirical distribution function of a sample of data is merely a scaled and normalized Poisson process and (2) certain analytical methods developed for calculating the distribution of certain additive functionals of Markov processes. The Smirnov distribution of the one-sided deviation is determined, together with the error terms in asymptotic distribution of this statistic and the von Mises ω^2 criterion. 28 pp. Published in *Teoriia Veroiatnostei*, Vol. 5, No. 4, 1960.

- **P-1193. A concept of stability in manpower planning.** W. Gorham and H. E. Scarf. 9-27-57. Unclassified.

An attempt to predict future skill composition by devising a method for computing stable skill distributions for an extremely simple model. The solutions of this model are then compared with the solutions of somewhat more realistic ones. A subsequent paper will describe how the technique considered should be combined with information concerning effectiveness in such a way as to offer insight into good retention goals. 21 pp. Illus.

P-1194. On communication processes involving learning and random duration. R. E. Bellman and R. E. Kalaba. 1-23-58. Unclassified.

An application of the functional-equation technique to communications problems arising from incomplete information. Using techniques of dynamic programming, a communication-system model is described, and some effects of incomplete information are discussed. This paper is a first step toward a more general theory. 18 pp. Illus. Published in the *IRE National Convention Record*, 1958—Part IV: *Information Theory*. Presented before the Institute of Radio Engineers at New York City, March 26, 1958.

P-1195. Economics of a dual capability. M. W. Hoag. 11-4-57. Unclassified.

A discussion of a "dual capability," defined as a military capability to hit prospective enemies hard with either strategic air bombing or with land armies complemented by supporting air and naval units. The argument that the U.S. cannot afford both of these capabilities and that the second capability should be eliminated is appraised. The military establishment the U.S. can afford is discussed, together with the likely cost of a realistic alternative to a dual capability. 11 pp. Published in *Ordinance*, March–April, 1958. Presented before the American Ordnance Association at New York City, December 4, 1957.

P-1197. Federal spending for national security. David Novick. 10-10-57. Unclassified.

A discussion of several factors expected to influence current and future trends in federal spending for national security purposes. These elements are (1) external political, military, or economic pressures; (2) the possibility of a mutual inspection system leading toward weapons control; (3) possible decisions to use international forces in place of national ones; (4) changing technology resulting in more effective weapons; (5) domestic demands for economy in government; (6) an inflation or deflation in the price level in the U.S.; and (7) the impact of budget and procurement decisions made prior to June, 1957. 16 pp. Published in the *Federal Expenditures Policy for Economic Growth and Stability*, Joint Economic Committee, Congress of the United

States, 85th Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., November 5, 1957. \$3.25. Presented before the Subcommittee on Fiscal Policy, Joint Economic Committee, Congress of the United States, November 21, 1957.

P-1200. Weighted PCM. Edward Bedrosian. 10-28-57. Unclassified.

A description of a modified form of pulse-code-modulation, called weighted PCM, wherein the relative amplitudes of the pulses within the pulse-code groups are adjusted so that the noise power is minimized in the reconstructed signal due to errors in transmission. A performance analysis and information-rate study compares a weighted 7-digit PCM system with a conventional one, and the selection of a suitable system-worth criterion is discussed. 21 pp. Illus. Published in the *IRE Transactions on Information Theory*, March, 1958.

● **P-1201. Sequential decision problems with a limited memory.** M. B. Marcus. 10-17-57. Unclassified.

A study based on the idea of sequential decision problems with a limited memory, taken from Herbert Robbins' paper, *A Sequential Decision Problem with a Finite Memory*. In these problems a random identically distributed sequence of Bernoulli trials occurs with a fixed probability p ; p is unknown. An experimenter tries to predict, prior to the happening of each event, what the event will be. To aid his prediction the experimenter knows the outcome of the preceding r events and the guesses he made concerning them. He attempts to optimize the proportion of times he guesses correctly over an infinite number of guesses. 14 pp. Table.

● **P-1202. The Systems Research Laboratory's air-defense experiments.** R. L. Chapman, J. L. Kennedy, A. Newell, and W. C. Biel. 10-23-57. Unclassified.

A discussion of some of the theoretical and methodological implications of the air-defense experiments conducted in RAND's Systems Research Laboratory between 1952 and 1954. It is shown that the desired performance of complex systems can be realized only through designing and managing them for operational flexibility, that this can be done by harnessing the learning ability of men in organizations, and that the simulation techniques developed provide a means for better understanding the adaption process in organizations for its use and control. 45 pp. Illus. Published in *Management Science*, April 1959. Presented before the American Psychological Association at San Francisco, California, September 1, 1955.

P-1205. The simplex method for quadratic programming. P. S. Wolfe. 4-1-59. Unclassified.

A computational procedure for finding the minimum of a quadratic function of variables subject to linear inequality constraints. The procedure is analogous to the simplex method for linear programming and is based on the Barankin-Dorfman procedure for this problem. 35 pp. Illus. Published in *Econometrica*, July, 1959.

P-1206. Optimum linear estimation for random processes as the limit of estimates based on sampled data. Peter Swerling. 10-24-57. Unclassified.

An analysis of a generalized form of the problem of optimum linear filtering and prediction for random processes. It is shown that, under very general conditions, the optimum linear estimation based on the received signal, observed continuously for a finite interval $a \leq t \leq b$, is the limit of optimum linear estimation in cases where the conventional generalized Wiener-Hopf integral equation technique has not been shown to yield a solution. 24 pp. Published in the *Convention Record of the Institute of Radio Engineers, Western Conference, 1958*. Presented before the Institute of Radio Engineers at Los Angeles, California, August 19, 1958.

P-1207. On inequalities for differential operators. R. E. Bellman. 10-28-57. Unclassified.

A study of a problem which states: Given that certain functionals of u and its derivatives belong to given L -classes over the infinite interval, what can be said about the L -classes of other functionals? Numerous results due to Landau, Kolmogoroff, Halperin-von Neumann, and Nagy are obtained by using a simple device from the theory of linear differential equations. In addition, some extensions are determined. 14 pp. Published in the *Proceedings of the American Mathematical Society*, August, 1958.

P-1208. Analytical approximations, volume XXV. C. Hastings, Jr., and E. Hastings. 10-28-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, and P-1184. 1 p. See also P-1217, P-1229, and P-1301.

P-1210. The intense stress field produced in the elastic earth by a bomb blast at the surface. Hyman Serbin. 8-23-57. Unclassified.

A theory for determining the free stress field in the earth caused by a bomb blast at the surface. It is assumed that the earth is an elastic solid. The analysis is confined to the intense stress field developed shortly after the burst. Stresses and displacements are calculated which can be compared with test data when available. 32 pp. Illus. Also published as RM-1967.

P-1212. Equilibrium points in games with vector payoffs. L. S. Shapley. 11-15-56. Unclassified.

An attempt to define and characterize the equilibrium-point solutions of games with payoffs that sometimes take the form of a vector. It is assumed the vector has components that represent amounts of different things of which the relative values are unknown. 9 pp. Also published as RM-1818. Published in the *Naval Research Logistics Quarterly*, March, 1959. Presented before the American Mathematical Society at the University of California at Los Angeles, November 15, 1957.

● **P-1213. On initial estimates for computing $a^{1/p}$ by Newton's method.** J. I. Derr. 1-31-58. Unclassified.

An attempt to evaluate $a^{1/p}$ for a in the interval $[0, 1]$ by Newton's method. The standard practice for digital computer programs is to use the uniform initial estimate of 1. By using a piecewise linear approximation as described in this paper, the computational effort can in the general case be considerably reduced. The convergence of Newton's method to $a^{1/p}$ is analyzed when the "first guess" is determined by the above approximation. 8 pp. Illus. Presented before the Association for Computing Machinery at the University of Illinois, June 13, 1958.

P-1214. A study of turbojet engine weight. G. B. W. Young. 3-6-59. Unclassified.

An analysis of turbojet engine weight with emphasis on the apparent density of the engine. An apparent-density equation is formulated that correlates well with the data for both nonafterburning and afterburning engines developed during the past ten years. This study may serve as an aid to propulsion engineers participating in syntheses of aircraft weapon systems. 19 pp. Illus.

P-1215. A tournament problem. L. R. Ford, Jr., and S. M. Johnson. 5-9-58. Unclassified.

An improved solution for the problem of finding the smallest number of direct pairwise comparisons which will always suffice to rank n objects according to some transitive characteristic. 8 pp. Illus. Published in *The American Mathematical Monthly*, May, 1959.

P-1216. A note on polynomial and separable games. D. Gale and O. A. Gross. 4-16-58. Unclassified.

A proof that given a pair of infinite metric spaces and a pair of respective finite mixed strategies on them, a separable game exists with bounded continuous payoff on their Cartesian product such that the given strategies constitute the unique solution of the game. If the spaces are identical, corresponding to any given finite mixture, a symmetric polynomial-like game can be obtained with bounded (skew-symmetric) continuous payoff so that the given strategy is the only optimal one. If the spaces are bounded subspaces of Euclidean n -space with sufficiently many cluster points in their closures, the payoff can be a polynomial and have the desired property. 16 pp. Also published as RM-2368. Published in the *Pacific Journal of Mathematics*, Winter 1958.

P-1217. Analytical approximations, volume XXVI. C. Hastings, Jr., and E. Hastings. 11-15-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, and P-1208. 2 pp. See also P-1229 and P-1301.

- **P-1218. Pairs of Russian words with high correlation.** D. G. Hays. 11-15-57. Unclassified.

A list of 2731 pairs of Russian words. The words in each pair are correlated at the 0.01 level of significance. These pairs were selected upon analysis of the occurrences of 200 words in 4037 pages of general text. 69 pp. Tables.

- **P-1219. The use of gaming and simulation devices in business.** W. A. Steger. 11-20-57. Unclassified.

A discourse on the use of gaming and simulation devices used in business to bring humans and machines together so that decision-making processes can be analyzed. Paper war games, RAND's Logistics Systems Laboratory, and top-management-decision gaming are given as examples. It is concluded that although the application of these devices to primarily economic situations is only in an embryonic stage, the results to date appear very promising. 6 pp. Presented before members of *Business Scope* (an economic newsletter) at Cambridge, Massachusetts, July 16, 1958.

- P-1220. Inventory control: exploiting the electronic data processor in the Air Force.** Leon Gainen. 11-20-57. Unclassified.

An application of the Air Force logistical electronic data processor (EDP) to that of inventory control of the materiel supporting two major aircraft of the U.S. Air Force. It is assumed that (1) a single-point logistical support concept is in operation for these weapons, (2) all bases flying these aircraft requisition spares from a Weapon Support Manager, and (3) although the management is centralized, the support materiel is strategically positioned at storage sites throughout the country. The functions of Air Force inventory control are part of the program described: input data control, substitution and allocation, transaction posting and management review, and due-in and shipment control. 23 pp. Published in *The Journal of Industrial Engineering*, January-February, 1959. Presented before the Electronic Data Processor Group at New York City, January 30, 1958.

- **P-1221. Approximate evaluation of an expression arising in the theory of time-delay estimation.** Peter Swerling. 11-23-57. Unclassified.

An extension to P-1185 in which a formula was derived for the greatest lower bound of the variance of unbiased estimates of the time delay between transmission and reception of a waveform, when the received waveform is observed in a background of additive white Gaussian noise. The present paper evaluates this expression approximately for a class of waveforms. 14 pp. See also P-1247. Presented before the Professional Group on Information Theory of the Institute of Radio Engineers at Los Angeles, California, April 17, 1958.

- P-1222. The meaning of limited war.** Bernard Brodie. 6-10-58. Unclassified.

A discourse on why limited war, defined as a war of restraint and of limited objectives during which no strategic bombing occurs, is preferable to total war. The price of limited war is always burdensome when compared with a no-war situation. As compared with the hazards and possible penalties of total war, the price is, if not low, at least tolerable. The purpose of limited war is to keep the price of war within bounds that are tolerable. 26 pp. Also published as RM-2224. Published in *Brassey's Annual*, ed. by Rear Admiral H. G. Thursfield, Brigadier C. N. Barclay, and Air Vice Marshal W. M. Yool, The Macmillan Company, New York, 1958. \$9.50. Presented before the National War College at Washington, D.C., November 12, 1957, and before the Institute of World Affairs at Pasadena, California, December 10, 1957.

- P-1223. On weighted PCM and mean square deviation.** R. E. Bellman and R. E. Kalaba. 12-2-57. Unclassified.

A proof that the functional equation technique of dynamic programming can be used advantageously in analyzing weighted pulse-code modulation (WPCM) communication systems. WPCM differs from normal PCM in that the amplitude of the transmitted pulses representing the binary digits in a pulse-code group is made to depend on the size of the group and on the power of two represented by the individual pulses. 9 pp. Illus. See also RM-2189, P-1416, and P-1500. Published in the *IRE Transactions on Information Theory*, March, 1958.

P-1224. The human side of the Berlin airlift. W. P. Davison. 12-3-57. Unclassified.
Part of a broader investigation concerned with the political and psychological aspects of the Berlin blockade of 1948 and 1949. The present paper discusses some of the human factors involved in the Berlin airlift: the importance of enthusiasm as a spur to improvisation; the way in which a clear definition of the mission helped to ensure coordination among the numerous agencies concerned; the strains that the grueling pace of the operation placed on the morale of air crews; the compensating motivations that combined to ensure high performance in spite of these strains; and the spontaneous contributions to good public relations made by individuals who took part in the airlift. 26 pp. Published in the *Air University Quarterly Review*, Fall, 1958.

P-1225. Secular trends in the birth ratio of whites, by states for the United States, 1870-1950. Bernard Okun. 12-3-57. Unclassified.

An examination of secular trends and cross-section patterns in the birth ratio of whites from 1870 to 1950 in the United States. The study shows marked regional and state differences in fertility and the existence in most states of the much-discussed phenomenon of the declining birth rate. 74 pp. Tables. Published as *Birth Rate Trends in the United States since 1870*, Johns Hopkins Press, Baltimore, 1958. \$3.50. Presented before the Econometric Society at Philadelphia, Pennsylvania, December 28, 1957.

P-1226. On the computational determination of the nature of solutions of nonlinear systems with stochastic inputs. R. E. Bellman, P. Brock, and M. Mizuki. 12-6-57. Unclassified.

The development of a technique for handling nonlinear dynamics problems which are difficult to investigate analytically or numerically if probabilistic terms are involved in their equations. The technique considered is practical only if a high-speed computer is available to perform the attendant computations. 12 pp. Illus. Published in the *Proceedings of the Computers in Control Systems Conference*, October, 1957. Presented before the American Institute of Industrial Engineers at Atlantic City, New Jersey, October 16-18, 1957.

• **P-1227. Dynamic-programming approach to optimal inventory processes with delay in delivery.** R. E. Bellman. 12-6-57. Unclassified.

A proof that a class of inventory processes with time lags can be treated in terms of sequences of functions of one variable, regardless of the length of the delay in delivery. A type of transformation is used which was applied previously in the study of engineering control processes. The usual dynamic-programming approach to inventory processes with delays in delivery leads to functions of many variables. This multi-dimensionality prevents the straightforward use of digital computers. 10 pp. Published in the *Quarterly of Applied Mathematics*, January 1961.

P-1228. The utility of a communication channel and applications to suboptimal information-handling procedures. M. B. Marcus. 12-9-57. Unclassified.

A study of the functional-equation technique of dynamic programming to analyze (1) some extensions of the Kelly-Bellman-Kalaba model of communication and (2) a null-zone reception system. The role of suboptimum systems is emphasized. 15 pp. Illus. Published in the *IRE Transactions on Information Theory*, December, 1958.

P-1229. Analytical approximations, volume XXVII. C. Hastings, Jr., and E. Hastings. 12-9-57. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, and P-1217. 2 pp. See also P-1301.

P-1230. Contrasts in large file memories for large-scale computers. J. A. Postley. 3-27-58. Unclassified.

A discussion of the relative advantages and disadvantages of sequential and random access memories as used with a large-scale computer. The author shows how some of these elements impinge on the objectives of the potential user of large-scale data-processing equipment. 6 pp. Published in the *Proceedings of the Western Joint Computer Conference*, 1958. Presented before the Western Joint Computer Conference at Los Angeles, California, May 8, 1958.

P-1231. A linear programming model of the gaseous-diffusion isotope-separation process. D. M. Fort. 12-12-57. Unclassified.

An attempt to show how the gaseous-diffusion process for separating uranium isotopes may be treated as a linear-programming model. The model is developed by the theoretical or engineering approach, as opposed to empirical methods based on statistical analysis of observations. The model may be useful in the economic analysis of complicated systems involving various feedbacks between gaseous diffusion plant, nuclear reactors, and other facilities involved in the production of nuclear materials and nuclear power. 24 pp. Illus. An abstract of this paper was published in *Econometrica*, October, 1958. Presented before the Econometric Society at Philadelphia, Pennsylvania, December 29, 1957.

P-1232. A note on preventative sampling. R. E. Kalaba. 12-13-57. Unclassified.

A proof that certain optimization problems of preventative sampling may be handled advantageously using the functional equation technique of dynamic programming. 6 pp. Published in *Operations Research*, May-June, 1958. Presented before the Econometric Society at Philadelphia, Pennsylvania, December 29, 1957.

● **P-1233. On a differential inequality of Cesari and Turner.** R. E. Bellman. 12-16-57. Unclassified.

A simplified proof, and indicated generalization, of a result of Cesari and Turner, "On a Lemma in the Direct Method of the Calculus of Variations." 5 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series II, Vol. VII, 1958.

● **P-1234. A first approach to logistics system simulation.** M. A. Geisler. 12-16-57. Unclassified.

A description of the early efforts of the Logistics Systems Laboratory to create simulation techniques that permit the study of the complex logistic systems under laboratory conditions. The simple modeling of logistic organizations used in PROLOG 1 is examined, together with the way in which they operated during the trial exercise. PROLOG 1 was useful in providing experience in simulation and modeling techniques and pointed the way for improved and more substantive experiments. 15 pp. Illus. Published in the *Naval Research Logistics Quarterly*, March 1960. Presented before the Institute of Management Science at Detroit, Michigan, October 17, 1957.

P-1236. The fitting of straight lines when both variables are subject to error. Albert Madansky. 10-7-58. Unclassified.

A study of the problem where X and Y are related by $Y = \alpha + \beta X$, where α and β are unknown, and where X and Y are observed with error (i.e., $x = X + u$ and $y = Y + v$). It is assumed that $Eu = Ev = 0$, and that the errors (u and v) are uncorrelated with the true values (X and Y). Solutions are described to the problem of obtaining consistent estimates of α and β from a sample of (x, y) 's, when various assumptions are made about properties of the errors and the true values other than those mentioned, and when various kinds of additional information are given which aid in constructing these consistent estimates. 66 pp. Table. Published in the *Journal of the American Statistical Association*, March, 1959.

● **P-1237. Experiments on circular arc and flat plate hydrofoil in noncavitating and full cavity flows.** B. R. Parkin. 12-19-57. Unclassified.

An investigation in the high-speed water tunnel of the two-dimensional hydrodynamic characteristics of sharp-edged hydrofoils. The lift, drag, and pitching moment are measured in cavitating and noncavitating flows for flat-plate and circular-arc profiles. The theory of Wu for the forces on sharp-edged profiles in full-cavity flow and the experimental results show good agreement over a wide range of attack angles. 42 pp. Illus. Published in the *Journal of Ship Research*, March 1958.

P-1239. Invariant imbedding, wave propagation, and the WKB approximation. R. E. Bellman and R. E. Kalaba. 12-26-57. Unclassified.

An attempt to indicate how wave propagation may be considered in terms of an over-all physical process as a sequence of local processes. The results are based on an algorithm that, in general, can yield divergent series. In addition, the paper shows that wave propagation can be discussed

in terms of reflection and refraction at infinitesimally separated interfaces and that the convergence of the Bremmer series can be established under a simple assumption concerning the slowly varying nature of the local wave number. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, April, 1958.

P-1240. Lead-time in modern weapons. David Novick. 12-26-57. Unclassified.

A discussion of the fundamental reason for lead-time, or the weeks to years required for the administrative and physical actions to translate wanting into getting. The author stresses that lead-time must be considered in the area of such complex equipment as satellites, ballistic missiles, and space flight vehicles. A start-then-stop, stop-then-start type of spending policy further complicates the already complex problem of lead-time in military equipment and makes it that much more difficult to fill today's requirements. 18 pp. Illus. Published in the *Federal Expenditure Policy for Economic Growth and Stability*, Joint Economic Committee, Congress of the United States, 85th Congress, 1st Session, U.S. Government Printing Office, Washington, D.C., November 18-27, 1957. \$2.00.

P-1241. A glossary of Russian physics on punched cards. K. E. Harper, D. G. Hays, and A. Koutsoudas. 12-26-57. Unclassified.

A description of a glossary of 6000 Russian forms, prepared by the University of Michigan and RAND, specifically for use in machine-translation research and operation. 3 pp. Published in *Mechanical Translation*, November, 1957.

P-1242-RC. On NATO pooling. M. W. Hoag. 12-30-57. Unclassified.

A review of two short books on NATO economics. The desirability of concentrating new efforts to pool resources in NATO upon the research and development area is appraised, and burden-sharing problems are briefly analyzed. 13 pp. Published in *World Politics*, April, 1958.

● **P-1243. Some methodological notes on the deflation of construction.** N. M. Kaplan. 5-15-59. Unclassified.

A description of and commentary on some of the procedures used in the measurement of changes in the value of construction at constant prices. The procedure which is almost always used involves the pricing of construction inputs rather than outputs because of the difficulties in measuring output as usually defined. The present paper proposes a redefinition of construction output and two alternative approaches to its measurement at constant prices. 36 pp. Tables. Published in the *Journal of the American Statistical Association*, September, 1959.

P-1244. Electric power for space flight. J. H. Huth. 12-10-57. Unclassified.

An examination of the expected electric-power requirements for satellite and interplanetary space-flight vehicles. Several possible means of meeting these requirements are outlined, and their present limitations and future potential are discussed. 17 pp. Tables. Presented before the Ninth Congress of the International Astronautical Federation at Amsterdam, Holland, August 24-30, 1958, and published in the proceedings of the Congress.

● **P-1245. Primes in the thousandth million.** C. L. Baker and F. J. Gruenberger. 1-6-58. Unclassified.

A method for calculating a table of 47,957 prime numbers, starting with 999,000,011 and ending with 999,999,937. 40 pp. Table.

● **P-1247. Note on the minimum variance of unbiased estimates of doppler shift.** Peter Swerling. 1-7-58. Unclassified.

An application of methods previously derived to the calculation of the minimum variance of unbiased estimates of doppler shift, when the received waveform is observed against a background of additive white Gaussian noise. 6 pp. See also P-1185 and P-1221. Presented before the Professional Group on Information Theory of the Institute of Radio Engineers at Los Angeles, California, April 17, 1958.

P-1248. Lunar flight. R. W. Buchheim. 1-7-58. Unclassified.

A summary outline of a lecture on basic mechanics of lunar flight for presentation to a class on Space Technology held at University of California at Los Angeles Extension. 7 pp

P-1250. Economics and military operations research. C. J. Hitch. 1-8-58. Unclassified.

An examination of some of the relations between operations research and economics. Operations research is defined as the use of systematic quantitative analysis to aid in the making of military and management decisions. Economics is described as a logic of choice rather than as a study of "those things that can be brought into relation with the measuring rod of money." The author suggests that an alliance between economics and military or governmental operations research may result in a new branch of endeavor, namely, an economics of government expenditure. See also P-1758. 25 pp. Published in *The Review of Economics and Statistics*, August, 1958.

P-1251. Studies in machine translation—2: research methodology. H. P. Edmundson and D. G. Hays. 12-16-57. Unclassified.

Part of a broader investigation designed to clarify the technical problems of computer application in linguistic research, to stimulate research in machine translation, and to encourage standardization of working materials. The present paper describes the research methods for machine translation of scientific Russian now used at RAND. The general approach is that of convergence by successive refinements. At each stage, automatic computing machinery is used for some aspects of translation, and for collecting and analyzing data about other aspects. 24 pp. Illus. Published in *Mechanical Translation*, July, 1958.

P-1252. Invariant imbedding and neutron transport theory—II: functional equations. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 3-5-58. Unclassified.

A discussion of some one-dimensional fission processes with particular attention to questions of critical length and energy dependence of the products of fission. Various interconnections between the functions used in the invariant-imbedding approach and the classical approach are indicated. In addition, it is shown how one may pass from the consideration of certain linear two-point boundary-value problems to nonlinear (Riccati type) initial-value problems. The former are useful for theoretical considerations, the latter for numerical computations. 30 pp. Illus. See also P-839, P-976, P-996, P-1102, P-1380, P-1390, P-1495, and T-63. Published in the *Journal of Mathematics and Mechanics*, September, 1958.

P-1253. The limits and problems of "decompression": the case of Hungary. Paul Kecskemeti. 1-13-58. Unclassified.

An attempt to show the working and effects of "decompression" in Hungary following Stalin's death. The revolt in Hungary might well have been forestalled by a consistent evolutionary policy or, failing this, by a recrudescence of terror. However, Moscow chose the middle course between these alternatives, because of an illusory faith in the unlimited efficacy of manipulation from above and an underestimation of the moral factor. The Hungarian developments have demonstrated the fallibility of Moscow's concept of manipulative decompression. 28 pp. Published in the *Annals of the American Academy of Political and Social Science*, May, 1958.

● **P-1254. An electronics engineer's view of operations research.** J. F. Digby. 5-13-58. Unclassified.

An address delivered before the National Conference on Aeronautical Electronics at Dayton, Ohio, May 13, 1958. The general nature of operations research is described, and some suggested applications relating to future problems of electronic systems are discussed. 11 pp. Presented before the National Conference on Aeronautical Electronics at Dayton, Ohio, May 13, 1958, and published in the proceedings of the Conference.

P-1255. Factors associated with income variability. R. B. Bristol, Jr. 12-29-57. Unclassified.

Part of a broader investigation concerned with the origins and effects of changes in economic attitudes. A reinterview study is examined, which was conducted by the Survey Research Center from 1954 to 1956 to determine the relation of common income changes to income level, age, education, and occupation. The author concludes that the sample as a whole tends to "regress" toward the sample mean income from one year to the next. However, certain characteristics of households appear to counteract this regression, some groups moving away from the sample mean over time. 20 pp. Tables. Published in *The American Economic Review*, May, 1958.

P-1256. Aerodynamics for space flight. E. P. Williams and C. Gazley, Jr. 2-24-58. Unclassified.

A review of the state of the art of hypersonic aerodynamics. The study considers the characteristics of hypersonic vehicles and their flight spectrum, of hypersonic and free-molecule flows, and of aerodynamic heating. 29 pp. Illus. A reprint of Lecture 9 of RAND's space-flight course, "An Introduction to Astronautics." Incorporated in *Space Handbook, Astronautics and Its Applications*, published by Random House, Inc., New York, 1959. \$3.95.

P-1259. Basic objectives of a continuing program of scientific research in outer space. W. W. Kellogg. 1-16-58. Unclassified.

A discussion of the basic objectives of the current, planned, and predictable programs of scientific research in outer space. The suitability of satellites and rockets in various roles of data collection is considered, and the importance of these data is examined. Many specific experiments relating to the earth, the moon, and the planets are outlined. 43 pp. Prepared in collaboration with members of the Technical Panel for the Earth Satellite Program. Published as "Research in Outer Space," in *Science*, April 11, 1958.

P-1260. On convergent perturbation expansions. R. E. Bellman and T. M. Fort. 1-21-58. Unclassified.

A proof that an expansion of the form $\Lambda(\epsilon) = \sum_{n=0}^{\infty} \lambda_n b(\epsilon)^n$, convergent for $\epsilon \geq 0$, can be obtained for the smallest characteristic value of the Sturm-Liouville equation $u'' + \lambda(f(x) + \epsilon g(x))u = 0$, $u(0) = u(1) = 0$. It is assumed that $f(x)$ and $g(x)$ are continuous functions in $0 \leq x \leq 1$ satisfying the conditions $f(x), g(x) \geq a^2$. 6 pp. Published in the *Quarterly of Applied Mathematics*, April, 1959.

• **P-1262. Air Force logistics: from research to policy.** A. R. Ferguson. 2-7-58. Unclassified.

An attempt to show that getting simple operations-research "solutions" to problems is really only the first step in getting a set of decision rules into practical use. Some decision rules are presented for setting stock levels for an Air Force inventory in those cases where a minimum of management per line item is appropriate. In particular, some problems of modifying and elaborating the decision rules for practical implementation are discussed. As the rules cover items which are consumed but not repaired at the stockage point in question, the paper considers how much to stock of any line items for which the decision has already been made that they be brought into the inventory. 15 pp. Illus. Published in the *Aeronautical Engineering Review*, January 1957. Presented before the Society for the Advancement of Management Conference on Operations Research at New York City, February 7, 1958.

P-1263. Studies of ionospheric radiophysics by means of satellites. W. C. Hoffman. 1-22-58. Unclassified.

Data on the use of artificial satellites for investigating ionospheric radiophysics, prepared for the forthcoming *Manual of IGY Rocket and Satellite Programs*. Topics discussed include radio tracking instrumentation and techniques, kinematic and geographical effects, cooperative observations, and ionospheric physics. 36 pp. Illus.

• **P-1264. Transient flows in networks.** David Gale. 4-11-58. Unclassified.

A study concerned with flows in two terminal dynamic networks as defined by Ford and Fulkerson. These authors have shown how to construct for each positive integer k a flow ϕ_k which maximizes the amount μ_k shipped from source to sink in k time periods. Their method leads to different functions ϕ_k for different values of k . The present paper shows that the problem can be solved by means of a single flow ϕ which at each time k maximizes the cumulative amount shipped from source to sink. The result holds even when the capacities and transit times in the network are allowed to vary with time. 12 pp. Illus. Also published as RM-2152. Published in the *Michigan Mathematical Journal*, Vol. 6, No. 1, 1959. Presented before the American Mathematical Society at Stanford University, Stanford, California, April 18, 1958.

• **P-1265. The image of dual Russia.** R. C. Tucker. 1-30-58. Unclassified.

A discourse on the image of dual Russia as embracing a consciousness of Russia as a double entity (the state and the society), and as comprising a range of attitudes with the relation between state

and society as one between conqueror and conquered. The author examines the background of this attitude and outlines how the state becomes repeatedly an outsider in the consciousness of the Russian people. 43 pp. Presented before the Conference on the Transformation of Russian Society since 1861, at Arden House, Harriman, New York, April 25-27, 1958.

P-1266-AEC. Approximate compressibilities of elements on the statistical model. W. G. McMillan. 1-30-58. Unclassified.

A discussion of the Thomas-Fermi (TF) model of the atom at zero temperature, known to give reasonable average values for a number of interesting atomic parameters. It is shown that the TF curve represents a reasonable average of the experimental values, the mean fractional deviation being within 50 per cent. 4 pp. Illus. Published in *The Physical Review*, July 15, 1958.

P-1267. What's wrong with military R and D? B. H. Klein. 3-7-58. Unclassified.

A study concerned with the possibilities for using more effectively present and future resources committed to research and development. Suggestions for accomplishing this are (1) to decontrol research and development substantially to get varieties of ideas into development to ensure rapid advances in military technology and (2) to develop a wide range of military capabilities to obtain a reasonable degree of military security. An alternative policy that emphasizes highly coordinated decisions, avoids "wasteful" duplication, and plans everything at the top, is not likely to give the U.S. the desired military superiority. 26 pp. Published in *Fortune*, May, 1958.

• **P-1268. Lunar flight trajectories.** R. W. Buchheim. 1-30-58. Unclassified.

A discussion of the motion of a vehicle as a particle in the environment of earth-moon space. The environment is described in terms of an idealized model in which the earth and moon are spherical bodies with the gravitational fields of point bodies. Some of the uses of a lunar rocket are listed. 50 pp. Illus. One of a series of lectures in a "Space Technology" course offered by the Extension Division of the University of California at Los Angeles.

P-1269. Future prospects for Soviet economic aid. Hans Heymann, Jr. 1-31-58. Unclassified.

A summary and full text of a talk given at the 12th Annual Conference of the Middle East Institute in Washington, D.C., January 31, 1958, and published in the transcript of that meeting. Such aspects of Middle East development are considered as (1) the size of current Soviet trade and aid effort, (2) the Soviet role in machinery exports, (3) the future of Soviet industrial exports to the underdeveloped countries, (4) the fact that Soviet aid is not a quantitative but a qualitative threat, and (5) future Soviet opportunities in the field of civil aviation. 17 pp.

• **P-1270. Lift of slender nose shapes according to Newtonian theory.** J. D. Cole. 2-4-58. Unclassified.

An extension of a method for predicting pressure forces and computing flow fields for slender bodies of revolution at zero incidence to the case of flow past bodies at an angle of attack. 19 pp. Illus. Also published as RM-2348.

P-1271. On a generalization of a result of Wintner. R. E. Bellman. 2-4-58. Unclassified.

A generalization of the Hukuwara stability theorem analogous to a recent generalization for second-order equations due to Wintner, as shown in the *Quarterly of Applied Mathematics*, January, 1958. 5 pp. Published in the *Quarterly of Applied Mathematics*, January, 1959.

• **P-1273. Programming and modification in the SHARE 709 system.** I. D. Greenwald and M. Kane. 3-19-58. Unclassified.

A discussion of that feature of the SHARE 709 system which permits the programmer to communicate with the machine and with itself entirely in a symbolic language. The compiler specifications (including instruction format, pseudo operations, program library, and system and programmer-macro operation generators) are described. Methods for handling symbolic input/output, debugging, and modification of a compiled program are considered. 14 pp. Published in the *Journal of the Association for Computing Machinery*, April 1959. Presented before the Association for Computing Machinery at the University of Illinois, June 11, 1958.

P-1275. What the factory worker knows about his factory. D. R. Fagg, C. Kaysen, and R. N. McKean. 2-7-58. Unclassified.

An exploratory attempt to measure the variability in the "knowledge" that workers have about their factory. Interviews with workers showed that the range of answers to specific questions was very wide and that the median answer was often far from the correct answer. In general, the more abstract the question, the greater was the variability and bias. 46 pp. Illus. Published in *The Journal of Business*, July, 1958.

P-1276. Note on the lift of slender nose shapes according to Newtonian theory. J. D. Cole. 1-24-58. Unclassified.

A method for predicting pressure forces and computing flow fields past bodies of revolution at an angle of attack. 3 pp. Published in the *Journal of the Aeronautical Sciences*, June, 1958.

P-1277. A command structure for complex information processing. J. C. Shaw, A. Newell, H. A. Simon, and T. O. Ellis. 8-20-58. Unclassified.

A discussion of recent research into digital computer programs—for discovering proofs to theorems in symbolic logic and playing chess—that has shown the desirability of languages better adapted to the requirements of such non-numeric programming tasks than are present-day machine languages. A command structure that allows more indirectness in programming and requires less knowledge of the location and form of the data is described. 54 pp. Illus. Presented before the Western Joint Computer Conference at Los Angeles, California, May 6, 1958, and published in the proceedings of that meeting.

P-1278. A network flow feasibility theorem and combinatorial applications. D. R. Fulkerson. 4-21-58. Unclassified.

A feasibility theorem for a capacitated network with certain of the nodes designed as sources, others as sinks. It is assumed that each source (sink) is required to send (receive) an amount which lies between prescribed bounds. A pair of conditions, necessary and sufficient for the existence of the required flow for the given conditions, is determined by using the max-flow min-cut theorem, and applications in connection with incidence matrices and the subgraph problem are discussed. 29 pp. Also published as RM-2159. Published in the *Canadian Journal of Mathematics*, Vol. XI, No. 3, 1959.

● **P-1280. Stability theory and adjoint operators for linear differential-difference equations.** R. E. Bellman and K. L. Cooke. 2-14-58. Unclassified.

An extension, to linear differential-difference equations, of a number of results familiar in the stability theory of ordinary linear differential equations. 61 pp. Published in the *Transactions of the American Mathematical Society*, September, 1959.

P-1281. On a linear-programming-combinatorial approach to the traveling-salesman problem. G. B. Dantzig, D. R. Fulkerson, and S. M. Johnson. 4-16-58. Unclassified.

A more detailed description of the linear-programming approach in solving the traveling salesman problem than that presented in P-510. The present study considers the example discussed by L. L. Barachet ("Graphic Solution of the Traveling Salesman Problem," published in *Operations Research*, Vol. 5, 1957), in which he describes a procedure of successively improving a solution by using certain necessary conditions for optimality and indicates that there is no guarantee that the final tour obtained by his approach is optimal. In addition, this paper starts with Barachet's initial tour, improves it, and gives a proof that his final solution is indeed optimal. 13 pp. Illus. See revised version RM-2321. Published in *Operations Research*, January-February, 1959.

P-1282. On the computational solution of dynamic programming processes—VIII: a bottleneck situation involving interdependent industries. R. E. Bellman and S. E. Dreyfus. 4-17-57. Unclassified.

A solution of a maximization problem arising in the study of the efficient use of a complex of interdependent industries. Assuming proportional costs and returns, it is shown that the dimen-

sionality of the problem can always be reduced by one, and that all the transformations occurring can be taken to be "shrinking transformations." These transformations greatly improve the efficiency of the method. 15 pp. Illus. Also published as RM-1752. Published in the *Naval Research Logistics Quarterly*, December, 1958.

- **P-1283. Science and doctrine in the Soviet Union.** Arnold Kramish. 2-14-58. Unclassified.

An attempt to determine (1) if a conflict really exists between Soviet doctrine and scientific progress, (2) if these successes are temporary, and (3) how the respective couplings of science and doctrine in the U.S. and USSR relate to the ultimate survival of their respective states. The author concludes that it is not clear that, from the viewpoint of short-range survival, the communist dogma is detrimental to science and that although the West can hope that Soviet science will ultimately prove erosive to Marxist-Leninist rigidity, it is disastrous to place any measure of reliance upon that expectation. 9 pp.

- **P-1284. Combinatorial processes and dynamic programming.** R. E. Bellman. 2-24-58. Unclassified.

A discussion of the application of dynamic-programming techniques to a class of combinatorial problems. The essential difficulty of these problems appears in their apparent lack of complexity, as it is usually either a question of performing a finite set of arithmetic operations or of determining the largest of a finite set of numbers. Although no specific numerical results are presented, references to extensive computational studies of S. E. Dreyfus and the author are given. 65 pp. Illus. Presented before the American Mathematical Society at New York City, April 24, 1958.

- P-1285. A simple device for assessing gun-camera film against banner targets.** J. L. Jenkins. 2-21-58. Unclassified.

A description of a small (3 in. \times 5 in.), inexpensive (less than 1 cent apiece) device that permits pilots to assess their own gun-camera film. An example of the device is given, and its use is illustrated. 6 pp. Illus. Published in the June, 1958, issue of "Fighter Weapons Newsletter," USAF Fighter Weapons School, Nellis Air Force Base, Nevada.

- **P-1286. Chemical thermodynamics in rocket nozzles.** W. B. White. 2-19-58. Unclassified.

A discussion of the application of thermodynamic methods to two typical rocket problems: the determination of rocket-motor performance and the geometric relations in rocket nozzles. Such aspects are considered as thermodynamic variables and their terminology, thermodynamic functions for gas mixtures, frozen equilibrium isentropic expansion, equilibrium composition, and the general isentropic process. 12 pp. Illus.

- P-1287. Theory of the solar aureole—part II: applications to atmospheric models.** Diran Deirmendjian. 2-20-58. Unclassified.

A continuation of P-1190, Part I of the study entitled "Scattering and Radiative Transfer," which considered the theory of the clear-sky aureole around the sun as a problem of radiative transfer in a plane-parallel scattering atmosphere. The present paper discusses the theory's applications concerned with the sky light in the immediate vicinity of the sun. 63 pp. Illus. Also published as RM-2133. Published in *Annales de Géophysique*, Vol. 15, 1959.

- P-1288. The simple economics of basic scientific research: a theoretical analysis.** R. R. Nelson. 4-28-58. Unclassified.

An examination of the simple economics of scientific research to determine how much expenditure on basic research is socially desirable and the extent to which a private firm can capture through the market the increased value of output resulting from the scientific research that it sponsors. This analysis indicates that (1) given our present economic structure, the social benefits of basic research are not adequately reflected in opportunities for private profit and (2) to the extent that we wish to maintain our competitive economy, basic research must be a matter of conscious social policy. 20 pp. Published in *The Journal of Political Economy*, April, 1959.

P-1289. A note on "Efficient estimation and local identification in latent class analysis." Albert Madansky. 2-24-58. Unclassified.

A commentary on R. B. McHugh's "Efficient Estimation and Local Identification in Latent Class Analysis," which appeared in *Psychometrika*, No. 21, 1956. The method in which McHugh obtains information functions is discussed, together with the conditions under which his estimator is consistent. 3 pp.

P-1290. A guide to the study of space law, including a selective bibliography on the legal and political aspects of space. J. C. Hogan. 4-1-58. Unclassified.

A guide to the study of space law which (1) enumerates some significant unanswered problem questions involving space law, (2) examines possible arrangements for the subject matter of space law, including suggested topics and categories, (3) lists scientific and general books and periodicals for lawyers interested in legal problems of space, and (4) presents an extensive—but still selective—bibliography of American and foreign sources on the law of space. 58 pp. Published in the *Saint Louis University Law Journal*, Spring, 1958.

● **P-1292. A proposed stagewise differential correction procedure for satellite tracking and prediction. Peter Swerling. 1-8-58. Unclassified.**

A procedure for tracking and predicting satellite orbits by stagewise differential corrections. Needed inputs to the prediction procedure are indicated: a selection of trajectory elements, the functions describing predicted or observed quantities as functions of the elements, and some knowledge of the error statistics of the observations. In addition, limitations on the accuracy of the prediction procedure are shown to occur when the elements are functions of time and when the observation error statistics and the prediction functions are imperfectly known. 19 pp. Presented before the Astrodynamics Colloquium of the Institute of Navigation at Los Angeles, California, May 15, 1958.

P-1293. Lunar trajectory studies. H. A. Lieske. 2-26-58. Unclassified.

An investigation, using a simplified model of the earth-moon system, of the variation of the initial trajectory parameters required for various types of missions in the earth-moon system. Typical transit trajectories for various missions near the moon are discussed, and estimates of initial errors are given. In addition, trajectories which pass near the moon and return to, or near, the earth are developed, and several examples are shown. 39 pp. Illus. Published in *ARDC Symposium on Guidance of Ballistic Missiles and Space Vehicles*, WADC TR 58-270. Presented before the ARDC Symposium on Guidance of Ballistic Missiles and Space Vehicles at Dayton, Ohio, March 12, 1958.

P-1294. The exploitation of the strength of "whiskers." G. A. Hoffman. 3-1-58. Unclassified.

Possible means for exploiting the phenomenal strength of fine crystal filaments, or "whiskers." Such filaments have demonstrated strengths in some cases approaching the theoretical limit of atomic cohesion. Reductions to one-fifth the weight of conventional structures appear feasible, a possibility of great interest in the design of astronautical vehicles. 15 pp. Illus. Published in *Astronautics*, August, 1958.

P-1295. The crisis in military affairs. W. W. Kaufmann. 2-28-58. Unclassified.

A critique of *Nuclear Weapons and Foreign Policy* by Henry A. Kissinger. This publication of the Council on Foreign Relations reviews the efforts made to devise a rational military posture, analyzes the principal problems in the field, and attempts to determine alternative solutions to these problems. This commentary praises Kissinger for his criticism of American military policy, but suggests that there are serious defects in his analysis of the threats with which the United States is confronted and in his appraisal of the preferred methods for reducing these threats. It is argued that Kissinger is particularly weak in his discussion of strategic air warfare and limited nuclear war. 43 pp. Published in *World Politics*, July, 1958.

P-1296. Citizenship: the viewpoint of science and technology. E. H. Vestine. 2-28-58. Unclassified.

Reflections on the role of the scientist as a citizen in modern American democracy. The question is considered of whether or not the scientist should be called upon more in the field of national

and international politics. In addition, the duty and responsibility of the community and nation to support the scientist in his work and life are discussed. 10 pp. Incorporated in the *American People's Encyclopedia Yearbook*, published by Spencer Press, Inc., Chicago, Illinois, 1958. \$10.00.

- **P-1297. The character of research and development in a competitive economy.** C. J. Hitch. 5-13-58. Unclassified.

A discussion of (1) how R and D can be used in our competitive economy to advance military technology and (2) what we can learn from the way R and D is conducted and managed in the competitive economy that we might emulate with advantage in the military services or the government. 13 pp. Presented before the National Science Foundation at Washington, D.C., May 20, 1958.

- P-1298. Economic prospects for communist China.** R. H. Moorsteen. 11-10-58. Unclassified.

A review of the First Five Year Plan of the USSR and that of the Chinese People's Republic to compare what the CPR has accomplished so far with its heavy industry with the achievements of a comparable period in Soviet history. The record to date shows that the Chinese are performing as well, or perhaps better, than the Russians at a comparable developmental stage. Chinese prospects for fulfilling the goals of the Second Five Year Plan in heavy industry—and for continuing its growth beyond the period of the Second Plan—depend on the ability of the CPR to direct a large share of the nation's output to industrial investment. 58 pp. Published in *World Politics*, January, 1959. Presented before the Association for Asian Studies at New York City, April 1, 1958.

- P-1299. Meteorological aspects of infrared operations.** J. D. Sartor. 3-3-58. Unclassified.

A discussion of the use of meteorological information and its limitations in infrared applications. Recent data on high-level clouds are presented, with some indication of their effect on infrared transmission. 16 pp. Illus. Presented before the Infrared Information Symposium at Los Angeles, California, March 5, 1958, and published in the proceedings of the Symposium.

- P-1301. Analytical approximations, volume XXVIII.** C. Hastings, Jr., and E. Hastings. 3-4-58. Unclassified.

A continuation of P-317, P-330, P-340, P-348, P-355, P-358, P-364, P-376, P-387, P-397, P-415, P-426, P-441, P-515, P-555, P-559, P-592, P-595, P-601, P-607, P-1033, P-1098, P-1117, P-1184, P-1208, P-1217, and P-1229. 6 pp.

- **P-1303. Trajectory fundamentals.** Samuel Herrick. 3-7-58. Unclassified.

A discussion of the basic physical laws governing the trajectories of objects in space. Illustrations of the influence of perturbations on trajectories are given, and various problems in calculating precise trajectories are examined. 40 pp. Illus. A reprint of Lecture 3 of RAND's space-flight course, "An Introduction to Astronautics."

- **P-1304. Certain ecological aspects of a closed lunar base.** I. Cooper, R. D. Holbrook, and H. A. Lang. 3-6-58. Unclassified.

A study of certain ecological aspects of a closed lunar base, with emphasis on the merits of possible mechanical and mechanical-green plant cycles. The comparison of these cycles is based on reasonable over-all system constraints, and an attempt is made to relate design studies to numbers of personnel involved. 16 pp. Illus. Presented before the American Rocket Society at Dallas, Texas, March 18, 1958.

- P-1305. Propagation considerations in space operations.** C. M. Crain. 3-6-58. Unclassified.

A discussion of several important propagation factors anticipated in radio links between the earth and space vehicles. Current concepts of the nature of extraterrestrial space to distances of several million miles from the earth are discussed from the standpoint of their implications for propagation. 17 pp. Illus. Presented before the ARDC Symposium on the Guidance of Ballistic Missiles and Space Vehicles at Dayton, Ohio, March 11-13, 1958, and published in the proceedings of the Symposium.

● **P-1307. Why beryllium?** J. C. DeHaven. 3-14-58. Unclassified.

A discussion of the reasons for interest in beryllium. Those listed are (1) the improved state of the art for determining the influence of materials on future aircraft and missile performance, (2) the increase in performance requirements where improvements in aerodynamic and engine states of the art alone cannot meet them with conventional structural materials, (3) better methods for determining how much we can afford to pay for a new material, (4) the greater availability of other raw materials once considered scarce, and (5) a better appreciation of the toxicity of beryllium and its compounds. 8 pp. Presented before the Society for Aircraft Materials and Process Engineers at Los Angeles, California, March 17, 1958.

● **P-1308. The theory of hedging and speculation in commodity futures.** L. L. Johnson. 3-6-59. Unclassified.

An attempt to outline the mechanics and purposes of a commodity-futures market, to discuss and appraise the theory of hedging and speculation as it exists today, to present a reformulated concept of hedging, and to construct a model that may both assist in clarifying the concepts of hedging and speculation and contribute to a better understanding of certain market phenomena. 31 pp. Illus. Published in *The Review of Economic Studies*, October 1960. Presented before the Econometric Society at Chicago, Illinois, December 27, 1958.

● **P-1309. Internal environment of manned space vehicles.** S. H. Dole. 2-24-58. Unclassified.

A summary of the primary elements of the environment within a manned space vehicle and a discussion of their effects on the human occupant. These elements include the composition and pressure of the atmosphere, gravitational forces, temperature, and radiation. 24 pp. Illus. A reprint of Lecture 16 of RAND's space-flight course, "An Introduction to Astronautics." Incorporated in *Space Handbook, Astronautics and Its Applications*, published by Random House, Inc., New York, 1959. \$3.95.

P-1312. The bureaucratic elite in Soviet politics. Myron Rush. 3-14-58. Unclassified.

A discussion of the capacity of the state bureaucracy to influence Soviet politics and institutional developments by examining its involvement in politics during Stalin's lifetime, since his death, and during Malenkov's and Khrushchev's bids to power. It is concluded that in a new succession crisis the bureaucratic elite (allied this time with groups recently subjected to renewed party control) may wage a more successful fight for political supremacy than during the five years following Stalin's death. 27 pp. Published in *The New Leader*, May 12, 1958.

P-1313. Criminal jurisdiction in overseas areas. F. T. Moore. 6-5-59. Unclassified.

A discussion of the problems surrounding the exercise of criminal jurisdiction over American military and civilian personnel in overseas areas and specifically those personnel attached to U.S. military bases. The subject of criminal jurisdiction is covered in that part of the treaties called the "status of forces" agreements, and the author treats the various factors which make those agreements difficult to apply. The significance of this subject for U.S. foreign policy is emphasized, since it deals with U.S. respect for the sovereignty of other nations. 38 pp. Published in *The Journal of Politics*, May 1959.

P-1314. The foundations and advances in game theory. H. M. Wagner. 2-14-58. Unclassified.

A commentary on R. Duncan Luce and Howard Raiffa's book, *Games and Decisions: Introduction and Critical Survey*, in relation to the foundations and advances in game theory. Besides recommending this book to economists interested in behavioral models of conflicts, the present paper discusses such topics as the game-theory model, utility axioms for stochastic events, utility and money, two-person games, *n*-person games, decision theory, and the future of game theory. 33 pp. Illus. Published in *The American Economic Review*, June, 1958.

P-1315. Comments on "Solution of the quota problem by a successive-reduction method." D. R. Fulkerson and D. Gale. 3-20-58. Unclassified.

A study which indicates that the "Quota Problem" as described by D. F. Votaw, Jr. (*Operations Research*, Vol. 6, No. 1), can be considered a special kind of maximum-flow problem. As such,

it can be solved more efficiently by the methods of Ford and Fulkerson (*Canadian Journal of Mathematics*, Vol. 9, 1957) than by the reduction method proposed by Votaw. 4 pp. Published in *Operations Research*, November–December, 1958.

- **P-1316. Asymptotic series for the solutions of linear differential-difference equations.** R. E. Bellman. 5-2-58. Unclassified.

A new technique for determining the asymptotic nature of the solution of linear differential-difference equations of the form $x'(t) = A(t)x(t) + B(t)x(t-1)$, where the coefficients $A(t)$ and $B(t)$ possess asymptotic series expansions. To illustrate the method, the scalar version of this equation is considered, together with the asymptotic series of the solution associated with the characteristic root of largest real part. 14 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series II, Vol. VII, 1958.

- P-1317. The Soviet employment of military strength for political purposes.** H. S. Dinerstein. 4-10-58. Unclassified.

A discussion of the widely acknowledged increase of Soviet military strength and its corresponding political prestige. This situation differs from the traditional pattern, mostly because a large component of this new military power is nuclear. It is concluded that the continued independence of non-communist areas is much more a function of their internal political strength than would have been the case if the Soviet Union had become a first-rank military power before the advent of nuclear weapons. 23 pp. Published in *The Annals of the American Academy of Political and Social Science*, July, 1958.

- **P-1318. A discussion of energy sources for space-communications.** J. H. Huth. 3-10-58. Unclassified.

A study of secondary power sources for equipment used in satellites or other space-flight vehicles. These sources include electrochemical systems, solar energy, and nuclear reactors. The potentials and limitations of these energy sources, particularly with respect to a space environment, are indicated. 25 pp. Illus. Presented before the Institute of Automotive Engineers at Los Angeles, California, April 21, 1958.

- P-1319. Chess-playing programs and the problem of complexity.** A. Newell, J. C. Shaw, and H. A. Simon. 9-4-58. Unclassified.

A discussion of the efforts at Los Alamos, IBM, and RAND to program computers to play chess. The programs developed are considered to be a sequence of attempts to get from programs that play chess by "system" to programs that reason about the chess situation. The various programs and the chess they play are described and compared to show the progress made in specifying complex processes and the nature of some of the difficulties involved. 57 pp. Illus. Published in the *IBM Journal of Research and Development*, October, 1958.

- P-1320. The processes of creative thinking.** A. Newell, J. C. Shaw, and H. A. Simon. 1-28-59. Unclassified.

An attempt (1) to determine whether a theory of creative thinking distinct from a theory of problem solving is needed, (2) to summarize what has been learned about problem solving by simulating certain human-problem-solving processes with digital computers, and (3) to indicate some of the differences in degree that may be observed in comparing relatively creative with relatively routine problem solving. 88 pp. Illus. Presented before a symposium at the University of Colorado, Boulder, Colorado, May 14, 1958.

- **P-1321. Automatic computers in machine-translation research.** D. G. Hays. 4-4-58. Unclassified.

A discussion of the elements that must be constructed before high-grade machine translation (MT) becomes a reality, the locations where work on MT is in progress, and the RAND method of research. Throughout the research process, automatic computers are used to reduce the labor and expense of this very large data-handling job. 10 pp. Incorporated in *Modern Trends in Documentation*, published by Pergamon Press, New York, 1959. \$5.00. Presented before a Symposium on Documentation or a Study of Information Retrieval Systems, held at the School of Library Science of the University of Southern California, Los Angeles, California, April 9–11, 1958.

- **P-1322. The penetration of planetary atmospheres.** C. Gazley, Jr. 2-24-58. Unclassified.

A review of the problems of penetrating a planetary atmosphere, together with a discussion of penetration techniques. These techniques are classified: (1) gradual entry into the atmosphere with relatively low deceleration loads and heating rates low enough so that the heat may be rejected by thermal radiation from the surface and (2) direct entry with higher deceleration loads and higher heating rates, the heat being absorbed by the body surface. 147 pp. Illus. A reprint of Lecture 10 of RAND's space-flight course, "An Introduction to Astronautics."

- **P-1323. Controlling consumers during future wars and their aftermaths.** Stephen Enke. 6-4-58. Unclassified.

A discussion of the government's responsibility to devise a program for mobilizing resources and restoring the economy to go into effect following an attack on the U.S. Alternative and conceivable wars are considered which resemble somewhat those of the past in their economic impacts and to which formerly suggested rationing schemes may still be applicable. An attempt is made to distinguish some alternative possible wars, to describe several different mobilization and rationing schemes, and to assess the possible usefulness of each such proposal in different economic situations resulting from these wars. 21 pp. Published in *The Quarterly Journal of Economics*, November, 1958.

- **P-1324. Japanese views on extraterrestrial law and order.** A. M. Halpern and J. C. Hogan. 4-1-58. Unclassified.

A paper concerned with several articles, written by Japanese scholars, on space law: (1) "Who Owns Outer Space," published in *Bungei Shunju*, November, 1957; (2) "Diplomacy in the Artificial Satellite Age," published in *Shukan Asahi*, October 28, 1957; and (3) "International Law for Outer Space," published in *Sankei-Jiji*, October 30, 1957. 19 pp. Published in the *American University Law Review*, Spring, 1958.

- **P-1325. On some communication network problems.** R. E. Kalaba. 6-3-59. Unclassified.

A discussion of several classes of communication network problems, including the leasing of minimal-cost connecting networks, the finding of optimal paths through networks, and the optimal routing of messages in networks. 37 pp. Illus. Presented before the 9th Symposium of Applied Mathematics at New York City, April 24-26, 1958.

- **P-1326. *War—1974*: a book review.** G. C. Reinhardt. 4-2-58. Unclassified.

A review of *War—1974*, by Lt. Col. Robert B. Rigg. The foreword claims that the book is "an indication of a military technique to come...based on actual...developments." The reviewer praises the book, not for its art, but for its logical development, trenchant insights, and mature evaluations. 6 pp. Published in *Army*, May, 1958.

- **P-1327. An introduction to guided missiles.** J. M. Chester. 4-4-58. Unclassified.

A talk presented before the Providence High School Parents' Guild at Burbank, California, May 21, 1958. Missiles are defined, their development is shown, their types are categorized, and their guidance and operation are described. Two specific guided missiles are considered and how their missions are accomplished. It is emphasized that continual effort is under way to increase the effectiveness of missiles against the increasing speed, range, and altitude of possible enemy bombers. 12 pp.

- **P-1328. Linguistic analysis in machine translation research.** H. P. Edmundson. 4-4-58. Unclassified.

A discussion of the concepts of linguistics pertinent to machine-translation research. The mathematical tools of symbolic logic, topology, statistics, and probability are examined from the standpoint of their present and potential contributions to machine translation, and machine-translation-research-methodology techniques are described. Specific attention is given to the problem of translation from Russian to English. 10 pp. Illus. Published in *Modern Trends in Documentation (Proceedings of a Symposium Held at the University of Southern California, April, 1958)*, ed. by Dr. Martha Boaz, Pergamon Press, London, England, 1959. \$5.00. Presented before the School of Library Science of the University of Southern California, Los Angeles, April 9, 1958.

P-1329. Review and discussion of the problem of binary laminar boundary layers—part I: stability considerations. J. F. Gross. 4-22-59. Unclassified.

A discussion of the problem of the laminar boundary layer in which heat and mass transfer occur simultaneously. The fundamental equations of a multicomponent boundary layer are derived, and previous work is reviewed. In addition, the stability of the binary laminar boundary layer is considered, and some possible methods of solution are indicated. 22 pp. Illus. Published in *Mitteilungen der Deutschen Gesellschaft für Raketentechnik und Raumfahrt*, Vol. 3, 1959. Presented before Deutsche Gesellschaft für Raketentechnik und Raumfahrt at Essen, Germany, October 24, 1958.

P-1330. Poisson's ratio for honeycomb sandwich cores. G. A. Hoffman. 4-7-58. Unclassified.

A derivation of Poisson's ratio for a variety of honeycomb cores having cells shaped as hexagons, squares, and rectangles. A relation is obtained between Poisson's ratio of the core and stiffness of the sandwich panel. Conclusions are drawn as to the desirability of using cores with large Poisson's ratio. 5 pp. Illus. A condensation of P-946. Published in the *Journal of the Aerospace Sciences*, August, 1958.

P-1331. Functional equations in the theory of dynamic programming—IX: variational analysis, analytic continuation, and imbedding of operators. R. E. Bellman and S. R. Lehman. 4-7-58. Unclassified.

An attempt to show how variational techniques can be applied to deduce properties (similar to those deduced from Green's function of various functional equations and properties of the resolvent operator) for complex and nonsymmetric operators. The study uses (1) a min-max variation and analytic continuation, if necessary, for complex operators and (2) an imbedding technique and analytic continuation, if required, for nonsymmetric operators. A nonsymmetric operator is imbedded within a family of symmetric operators associated with a variational problem. Once the variational problem is formulated, the functional-equation techniques of dynamic-programming theory are applied. 5 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September, 1958.

P-1332. Functional equations in the theory of dynamic programming—X: resolvents, characteristic functions, and values. R. E. Bellman and S. R. Lehman. 11-14-58. Unclassified.

An application of the functional-equation technique of dynamic programming to the variational problem yielding the equation $(pu')' + (r(x) + \lambda q(x))u = v(x)$, $u(a) = u(1) = 0$. With the introduction of the parameter λ , the resolvent operator is studied and the variational relations derived for the characteristic values and functions of the associated Sturm-Liouville equation. 28 pp. Published in the *Duke Mathematical Journal*, March 1960.

P-1333. Approximation in policy space, linear, and nonlinear programming. R. E. Bellman. 4-7-58. Unclassified.

Part of a broader investigation concerned with the applicability of the technique of successive approximations to a variety of nonlinear and multidimensional problems arising in the theory of dynamic programming. The present paper indicates how the method of dynamic-programming theory, in the guise of approximation in policy space, can be used to yield monotone approximation for linear, quadratic, and nonlinear programming. 7 pp.

P-1334. The Logistics Systems Laboratory as a research tool. R. M. Rauner. 4-7-58. Unclassified.

The text of a talk concerned with RAND's Logistics Systems Laboratory (LSL), originated in October, 1956, to study some of the organizational, data processing, and policy problems encountered in the logistic support of Air Force operations. Laboratory Problem I (LP-I) is examined, together with LSL's plans for the future. 12 pp. Presented before the Operations Research Society of America at the University of California at Los Angeles, April 4, 1958.

P-1335. Space-vehicle environment. C. Gazley, Jr., W. W. Kellogg, and E. H. Vestine. 6-15-59. Unclassified.

A discussion of various physical characteristics of the natural space environment in the solar system. In particular, a survey is made of the characteristics of solar radiations, the effects of solar and other thermal radiations on vehicle temperature, the characteristics of the earth's magnetic fields and other magnetic fields in space, the earth's exosphere and the solar corona, cosmic rays, and meteoroids. In addition, the probability of vehicle skin penetration by meteoroids is estimated. 60 pp. Illus. Published in the *Journal of the Aerospace Sciences*, December 1959. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, July 8-11, 1958.

● **P-1336. The Russian urban worker: from serf to proletarian.** J. G. Gliksman. 4-7-58. Unclassified.

A discussion of the formation of the Russian working class, from the emancipation of the serfs in 1861 to the upheaval of 1928-1932 in industry and agriculture. Emerging from serfs and peasantry, this class acquired the features of a modern urban proletariat in the continuous process of the country's industrialization. The author questions whether the Soviet regime will be able to continue its present course of internal relaxation toward the proletariat without relinquishing at least some of its principal political, military, and economic goals, and whether, if faced with this choice, the regime will feel compelled to turn to more coercive methods. 29 pp. Incorporated in *The Transformation of Russian Society: Aspects of Social Change since 1861*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$9.75. Presented before the Conference on the Transformation of Russian Society since 1861, held at Arden House, Harriman, New York, April 25-27, 1958.

P-1337. Sweepback theory for shock waves at hypersonic speeds. J. D. Cole. 4-4-58. Unclassified.

Results (given by hypersonic small-deflection theory) for the pressure coefficient, density, and other characteristics behind the shock wave on a sweptback wedge. A comparison with exact theory can be made, at infinite Mach number, to show that the hypersonic small-deflection theory yields very good results out as far as sweepbacks sufficiently large to cause detachment. 13 pp. Illus. Also published as RM-1991.

P-1338. Temperature dependence of the Rayleigh scattering coefficient in the atmosphere. Diran Deirmendjian. 4-10-58. Unclassified.

A discussion of R. Penndorf's computation of the attenuation coefficient of standard air as a function of temperature and wavelength (*Journal of the Optical Society of America*, Vol. 47, 1957). The author shows that, within the atmosphere, variations in air temperature do not usually occur independently of the pressure, as might be implied by Penndorf's analysis, and that the transmission of visible radiation, through the whole (hazeless and dry) atmosphere, is a function of the mass of air in the path of the radiation, regardless of the temperature distribution. 7 pp. Published in the *Journal of the Optical Society of America*, Vol. 48, December, 1958.

P-1339. The writer, the editor, the publisher, and the reader. B. W. Haydon. 4-10-58. Unclassified.

A discussion of the quality control of scientific literature as a means of ameliorating problems of documentation, storage, retrieval, and abstracting. This goal may be accomplished, provided (1) scientists refrain from publishing trivial material and write only useful scientific information, (2) journal editors and book publishers become more selective in what they print, and (3) readers use more discrimination in what they buy and read. 7 pp.

P-1340-RC. Economic research on Southeast Asia in the United States: status and needs. Charles Wolf, Jr. 4-16-58. Unclassified.

Remarks delivered before the Association for Asian Studies at New York City, April 2, 1958, on the status and needs of Southeast Asian economic research. The author maintains that most economic research on Southeast Asia in the United States is and has been descriptive, and that the research ought to be more scientific, or rigorously theoretical, than it has generally been. 6 pp.

- **P-1341. A preface to U.S. policy toward Russia.** R. C. Tucker. 3-5-58. Unclassified.

An attempt to define and clarify U.S. foreign policy toward Russia, with emphasis on the political rather than the military aspects of the situation. Among some basic concepts considered are the U.S. foreign policy interest in security, external requirements of U.S. security, the general goal of U.S. diplomacy, the mutual security interest, the present postures of Russia and America, and the method of analysis used. In addition, the dangers of armed violence are discussed, together with the dangers of Soviet political encroachment (e.g., the neutralization of collective defenses, the acquisition of excessive Soviet influence, the aggrandizement of the Soviet bloc, the moral-political isolation of America, and the preservation of the Soviet empire). 138 pp.

- P-1342. The reciprocal fear of surprise attack.** T. C. Schelling. 5-28-58. Unclassified.

An analysis of the idea that initial probabilities of surprise attack become larger through a "multiplier" effect as a result of the compounding of each person's fear of what the other fears. In particular, the study examines whether and how this phenomenon can arise through a rational calculation of probabilities, or a rational choice of strategy, by two players who appreciate the nature of their predicament. An attempt is made to determine whether an explicit model of this predicament can be built in which two rational players are victims of the logic that governs their expectations of each other. 28 pp. Illus. An abstract of this paper was published in *Econometrica*, July, 1959. Presented before the Econometric Society at Chicago, Illinois, December 27, 1958. Incorporated as Chapter X in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25.

- P-1343. Use of a simulation laboratory to study the organization and effectiveness of Air Force logistics.** Stephen Enke. 4-16-58. Unclassified.

A discussion of the Logistics Systems Laboratory, its origin and objectives, and Laboratory Problem I. Some methodological issues are considered, together with special management difficulties. The author concludes that there is no question about whether simulation or gaming relating to Air Force logistics is worth while, but rather what proportion of the budget it should absorb. 9 pp. Published in *The Journal of Business*, October, 1958. Presented before the Operations Research Society of America at Boston, Massachusetts, May, 1958.

- **P-1344. Physics of solar-terrestrial space: lunar flight.** E. H. Vestine. 2-24-58. Unclassified.

A discussion of the physical conditions in space near the earth, moon, and sun. In particular, the density, radiation, temperature, wave propagation, magnetic fields, and the effects of these factors on space flights are examined. 18 pp. Illus. A reprint of Lecture 21 of RAND's space-flight course, "An Introduction to Astronautics."

- P-1345. On the shortest route through a network.** G. B. Dantzig. 4-29-59. Unclassified.

A procedure for finding the shortest route from a given origin to all other nodes in the network or to a particular destination point when little effort is required to arrange distances in increasing order by nodes or to skip consideration of arcs into nodes whose shortest route to the origin has been determined earlier in the computation. It is shown that $n(n-1)/2$ comparisons are needed to obtain the shortest route from a given origin to all other nodes and less between two fixed nodes. 8 pp. Illus. Published in *Management Science*, January 1960.

- P-1347. A marginal cost function for highway construction and operation.** A. R. Ferguson. 12-30-57. Unclassified.

A study originally prepared in 1953 for the Virginia Highway Users Association in connection with legislative hearings on highway taxation in Virginia. An attempt is made to develop a cost function adequate for assigning highway costs to various classes of vehicles. Costs are defined as expenditures of the Highway Department in the construction and operation of the highway system. The author concludes that (1) highway costs are a function of vehicle gross weight, axle weight, and vehicle and truck miles, and (2) a large fraction of the costs are insensitive to vehicle characteristics. 30 pp. Tables. Published in *The American Economic Review*, May, 1958. Presented before the American Economic Association at Philadelphia, Pennsylvania, December 30, 1957.

P-1348. Some finite population unbiased ratio and regression estimators. M. R. Mickey. 4-25-58. Unclassified.

A presentation of a class of ratio- and regression-type estimators such that the estimators are unbiased for random sampling, without replacement, from a finite population. Non-negative unbiased estimators of estimator variance are provided for a subclass. Similar results are given for the case of generalized procedures of sampling without replacement. Efficiency is compared with comparable estimation-sample-selection methods for this case. 39 pp. Tables. Published in the *Journal of the American Statistical Association*, September 1959.

● **P-1349-RC. Is water different?** J. C. DeHaven. 5-25-60. Unclassified.

A presentation of the argument that water is not different from other resources, but that the features of its supply, and custom and development of water law, have largely placed it in the public domain. Consequently, developing new supplies of water and its distribution are often the responsibility of government agencies. The study emphasizes the importance of the citizen-taxpayer's becoming informed of the economic aspects of water supply to avoid the wasteful investment of our other resources by government agencies in an effort to produce more water. 16 pp. Tables. Incorporated in *Water Supply—Economics, Technology, and Policy*, published by The University of Chicago Press, Chicago, Illinois, 1960. \$7.50. Presented before the League of Women Voters at Santa Monica, California, April 26, 1958.

● **P-1350. Scientific exploration in the fringe of space.** W. W. Kellogg. 2-4-58. Unclassified.

A reprint of Lecture 20 of a RAND course entitled "An Introduction to Astronautics," published as S-72. The development of current theories on the structure of the upper atmosphere is described. These theories pertain to temperature and density distribution, the kinds of gas present, electrical properties, and upper-atmosphere winds. The need for ground-based, rocket, and satellite experiments to obtain further information on the fringe of space is emphasized, and possible experiments are suggested. 27 pp. Illus.

P-1351. The political position of the Soviet army since Stalin. Leon Gouré. 4-23-58. Unclassified.

A discussion of the relationship of the Soviet Army to the Communist Party and its leaders since Stalin's death. The fortunes of the armed forces varied in direct proportion to the intensity of the factional struggle within the "collective leadership." Whenever the political struggle approached a climax, the military pressed their demands because the competing political leaders were forced to bid for their support. Stalin's death led to an almost immediate rise in the status and prestige of the armed forces, and in particular of Zhukov. Following his dismissal, party control over the armed forces increased rapidly. In the event of another renewed and prolonged power struggle in the leadership, the political role of the armed forces would doubtless be increased and the dominant position of the party drastically reduced. 22 pp. Published in *The New Leader*, June 9, 1958.

P-1352. Studies in machine translation—3: résumé of machine codes and card formats. H. P. Edmundson, D. G. Hays, and R. I. Sutton. 8-18-58. Unclassified.

One of a series of studies describing the methods now in use for research on machine translation (MT) at RAND. The present paper describes the principal punched-card formats in use and the special codes used for punching information into the cards. 31 pp. Illus. Also published as RM-2064.

P-1353. General description of a cooperative anticollision system for aircraft. L. B. Early. 2-8-58. Unclassified.

A discussion of a cooperative anticollision system for aircraft which transmits, to mutually equipped aircraft, data on the presence, position, and course of the other, and the closing or opening of the distance between the aircraft. This system may be used as an interim device until research can derive a better method for avoiding airplane accidents and the constant level of near misses. 4 pp. Illus.

P-1354. Soviet industry five years after Stalin. Oleg Hoeffding. 4-28-58. Unclassified.

An appraisal of the current condition of Soviet industry with emphasis on (1) the tendency for the Soviet rate of growth of industrial output to decline in recent years from the outstandingly high rates of the early postwar years and (2) the so-called "scrapping of the Sixth Five Year Plan." The author warns the West not to be complacent about the growing pains of overly hasty Soviet industrial growth, but instead to promote comparably the dynamic expansion of advanced and backward economies in the free world. 10 pp. Published in *The New Leader*, June 2, 1958.

P-1355. On the maximum likelihood estimate of the correlation coefficient. Albert Madansky. 4-30-58. Unclassified.

A study which determines the maximum likelihood estimate of the correlation coefficient for the bivariate normal distribution when the variances are known. 7 pp.

P-1356. On "Heuristic problem solving" by Simon and Newell. R. E. Bellman. 4-29-58. Unclassified.

A criticism of the statements of Simon and Newell in their article "Heuristic Problem Solving," which was published in *Operations Research*, January-February, 1958. The author comments on the predictions made about the use of computers within ten years, the discovery of important mathematical theorems, the writing of worthwhile music, the future dependence of the major part of the field of psychology upon computers, and the dethroning of the current world chess champion by a computer. 2 pp. Published in *Operations Research*, May-June, 1958.

P-1358. Least squares estimation in finite Markov processes. Albert Madansky. 5-5-58. Unclassified.

A consistent estimate of the transitional probability matrix of a finite Markov process in the case when at each point in time only the proportions of the sample in each state are known. It is shown that this estimate is asymptotically more efficient, in a sense defined in this paper, than previously considered estimates for this matrix. 12 pp. Published in *Psychometrika*, June, 1959.

P-1359. Solving linear programs in integers. G. B. Dantzig. 7-11-58. Unclassified.

A discussion of a recent result of Gomory (Princeton) for solving linear programs in integers and for adding linear inequality constraints to a linear-programming problem automatically in such a way that the extreme points of the resulting convex contain only integral solutions in the neighborhood of the minimum. The present paper gives an alternative method for generating these additional constraints in an easy, practical way. 6 pp. See revised version RM-2209. Published in the *Naval Research Logistics Quarterly*, March 1959.

P-1360. Elastic equilibrium of a plate with a reinforced elliptical hole. Eugene Levin. 5-5-58. Unclassified.

A solution to the generalized plane-stress problem produced when an infinite thin plate with an elliptical hole reinforced by a confocal elliptical ring is subjected to loads in the plane. The solution is obtained using the complex variable techniques of Muskhelishvili. 26 pp. Illus. Published in the *Journal of Applied Mechanics*, June 1960.

P-1361. Representation theorems and inequalities for Hermitian matrices. R. E. Bellman. 5-6-58. Unclassified.

An attempt to establish an analogue of a certain integral representation for positive definite Hermitian matrices. The study uses (1) this result to derive a number of known inequalities, (2) the integral representation considered and the Hermitian analogue to derive a partial generalization of a recent inequality of Hua, and (3) a deeper representation theorem of Siegel and Ingham to obtain a further generalization. The result for Hermitian matrices requires a generalization of the Siegel result due to Braun. A generalization in a different direction enables still further results to be obtained. 12 pp. Published in the *Duke Mathematical Journal*, September, 1959.

P-1362. Design of a management information system. D. S. Stoller and R. L. Van Horn. 11-22-58. Unclassified.

An investigation of the problem of designing a management information system for operations and maintenance control of a major weapon system. Different orientations are examined, together with both operating and planning decisions. In addition, an attempt is made to develop design objectives

for an information system. 12 pp. Published in *Management Technology*, Monograph Number 1, The Institute of Management Sciences, 1960. Presented before the Operations Research Society of America at Boston, Massachusetts, May 16, 1958, and before the American Ordnance Association, Committee on Proving Ground Instrumentation, at the Pacific Missile Range, Pt. Mugu, California, July 23, 1958.

P-1363. Aggregation of utility functions. Edmund Eisenberg. 7-14-58. Unclassified.

A proof that if in an economy each consumer has a fixed income and acts so as to maximize a concave, continuous, and homogeneous utility function, then both a social welfare and a community utility function exist. This proof serves as an aid in defining unambiguously the index of the community standard of living as well as the price index. 30 pp. Published in *Management Science*, July 1961.

P-1364-RC. Price-quantity adjustments in multiple markets with rising demands. K. J. Arrow. 5-7-58. Unclassified.

Part of a broader economic analysis of the engineer-scientist market. The present paper models the effect of steady upward shifts in some or all demand functions in the adjustment of prices and quantities. It is shown that the "shortage" in each market increases to a limiting value, while the difference between actual and market-clearing prices approaches a limit which lessens as the speed of reaction in the different markets increases. 13 pp. See also P-1365-RC. Incorporated in *Mathematical Methods in the Social Sciences*, 1959, published by Stanford University Press, Stanford, California, 1960. \$8.50.

P-1365-RC. Dynamic shortages and price rises: the engineer-scientist case. K. J. Arrow and W. M. Capron. 5-7-58. Unclassified.

A discussion of the rapid increase in demand for the services of scientists and engineers in the U.S. since World War II and, in particular, of the "shortage" conditions in the past seven years. These conditions result basically from a failure of the price of such services to adjust upward as rapidly as warranted by the increasing demand, given the supply schedule of such services. While the relative rigidity of supply in the short run is unpleasant (from the buyers' standpoint), and the price rise required to restore the market to equilibrium may seem to be great, it is only by permitting the market to react to the rising demand that it can allocate engineer-scientists in the short run and obtain the desired increase in supply in the longer run. 21 pp. Illus. See also P-1364-RC. Published in *The Quarterly Journal of Economics*, May, 1959.

P-1366. Interservice supply management within the Defense Department. Stephen Enke. 5-8-58. Unclassified.

A discussion of the increased integration of many of the supply activities of the four Services within the Department of Defense. Although most of the still unintegrated logistics activities tend to be peculiar in some way to a particular Service, and so should never be centralized, there are at present many supply items sufficiently common to justify more coordinated management. This study examines some of these possibilities, together with a reconstitution and extension of the present Interservice Supply Support Committee. 15 pp. Tables.

● **P-1368. On the economic management of large organizations: a case study in military logistics involving laboratory simulation.** Stephen Enke. 5-8-58. Unclassified.

An attempt (1) to describe the economic problems of supporting aircraft with spares, the policies developed, and the laboratory simulation that assessed them, and (2) to present a case study in the use of laboratory simulation as a complement to more traditional economic research into the efficiency of large organizations. While human simulation plays a part in comparing, testing, and evolving policy innovations supposed to increase the efficiency of organizations that are so large that their sub-units have difficulty in communicating or possess conflicting interests, gaming of this kind must be an adjunct of a larger research effort that uses traditional means of research. 38 pp. Tables. Presented before the Operations Research Society of America at Boston, Massachusetts, May 15, 1958.

● **P-1369. Introduction to dynamic programming.** S. E. Dreyfus. 6-4-58. Unclassified.

A discussion of the conceptual framework of dynamic programming and an indication of some of the types of processes that can be treated. The functional-equation method of formulating

multistage-decision-process problems is explained. In addition, several classes of problems to which this technique has proved applicable are given to illustrate some analytic and computational devices for resolving these problems. 13 pp.

P-1370. Manufacturers' inventory cycles and monetary policy. D. M. Eisemann. 5-9-58. Unclassified.

A paper concerned with the availability of credit as one of the factors which many businessmen must consider when planning their inventory policy. When inventories are rising rapidly, firms become increasingly dependent on bank credit, and a change in credit policy may have an important influence on inventory fluctuations. This study attempts to measure the impact monetary policy may have on inventories and to examine the limitations such a policy may face. 17 pp. Illus. Published in the *Proceedings of the Business and Economic Statistics Section of the American Statistical Association*, June, 1958. A revised version of this paper was published in the *Journal of the American Statistical Association*, September, 1958. Presented before the American Statistical Association at Atlantic City, New Jersey, September 10, 1957.

P-1371. General characteristics of binary boundary layers with applications to sublimation cooling. J. F. Gross, D. J. Masson, and C. Gazley, Jr. 8-1-58. Unclassified.

An examination of several theoretical analyses of laminar and turbulent binary boundary layers. The application of these studies to mass-transfer cooling systems is discussed, with emphasis on sublimation and ablation cooling. The importance of the injection of foreign materials on the stability characteristics of the flow is indicated, and experimental results show nontransitional flow for moderate injection rates even with light gases. 58 pp. Illus. Presented before the High-speed Aerodynamics and Structures Symposium at San Diego, California, March 26, 1958, and published in the proceedings of the Symposium.

• **P-1372-RC. The relation of salary to the supply of scientists and engineers.** J. C. DeHaven. 5-16-58. Unclassified.

A model which demonstrates how the pecuniary and nonpecuniary factors of total income may operate on the margin to determine the numbers of people in different occupations. The net present income values at age 18 for several occupations—building-construction workers, chemists, and chemical engineers—are calculated using actual income and cost data to show the relevant pecuniary factors which may influence young people in their choices of careers. The implications for three meanings of "shortage" are discussed in terms of the numbers of people who may choose scientific occupations. In addition, an estimate is made of the future trend of income for chemical engineers in respect to other occupations. 27 pp. Illus. Presented before the American Institute of Chemical Engineers at Philadelphia, Pennsylvania, June 22, 1958.

P-1373. Talmudism in Soviet politics. Myron Rush. 1-2-59. Unclassified.

A discussion of (1) the importance of esoteric communications in extending our knowledge of Soviet politics and (2) the kinds of knowledge these studies provide and how to conduct them. By this or some related procedure the researches of "Talmudists," as of Soviet specialists generally, can be more widely exploited by officials who must estimate future political developments in the USSR. These researches can provide new evidence on important problems, bring plausible hypotheses to areas of admitted ignorance, raise provocative objections to views held uncritically, and stimulate reflection about the very nature of the Soviet political system. 15 pp. Published in *World Politics*, July, 1959.

P-1374. On the application of dynamic programming to a class of implicit variational problems. R. E. Bellman and J. M. Richardson. 5-14-58. Unclassified.

A discussion of a class of variational problems arising in economic and engineering control processes which may be solved computationally by combining the theory of dynamic programming with modern digital computers. A particular example of a problem of less explicit nature is discussed. It is one in which a preassigned function is required as a minimum for the first value of T for which $x_1(T) = a_1$, a given value. 15 pp. Also published as RM-2354. Published in the *Quarterly of Applied Mathematics*, October, 1959.

P-1375. Use of mathematical models for logistical planning. J. D. Little. 5-19-58. Unclassified.

A study that defines machine models and explains their uses in logistic planning and experimentation. As examples, a description is given of "Laboratory Project 1" (a man-machine model) and of the Missile Support Model (a machine model used in "Laboratory Project 2"). The paper discusses the purpose of these models, the general procedure used in creating the models, the trouble areas found in this creative period, the results obtained from the running of the models, the trouble areas found in the running of the models, and other possible uses of models. 17 pp. Presented before the Management Seminar on Electronic Data Processing at Brookley Air Force Base, Mobile, Alabama, April 14, 1958.

P-1376. A method for determining supply quantity for the case of Poisson distribution of demand. M. R. Mickey, Jr. 5-15-58. Unclassified.

A study of the problem of determining the number of units of an item to be supplied against a future demand, on the basis of the past record of demand for that item. A method is described for the case of Poisson distribution of demand and known relation between the expected demand for the experience and the future periods. 15 pp. Published in the *Naval Research Logistics Quarterly*, December 1959.

P-1377. Strategy and economics: a Soviet view. Oleg Hoeffding. 5-16-58. Unclassified.

A review of A. N. Lagovskii's book, *Strategy and Economics* (published by the USSR Ministry of Defense, September, 1957) which deals with the role of economics in modern war. The book considers how to groom the Soviet "economic potential" for a future war, how to use it in that war, how to identify the vulnerabilities in the U.S.-NATO "economic potential," and how to strike at them in war. There is no evidence that this book represents official Soviet doctrine, but the book cannot be dismissed as the work of an isolated individual. Evidently, high Soviet military authorities favor dissemination of Lagovskii's outmoded views among staff officers. 13 pp. Published in *World Politics*, January 1959.

P-1379. Consensus of subjective probabilities: the pari-mutuel method. E. Eisenberg and D. Gale. 5-22-58. Unclassified.

A discussion of the pari-mutuel system of betting on horse races in which the final track odds are in some sense a consensus of the "subjective odds" of the individual bettors weighted by the amounts in their bets. The authors formulate the properties which this consensus must possess and prove that there always exists a unique set of odds having the required properties. 9 pp. Published in *The Annals of Mathematical Statistics*, March 1959.

P-1380. Invariant imbedding and neutron transport theory: a generalized approach. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 2-7-58. Unclassified.

One of a series of studies concerned with the application of the theory of invariant imbedding to a variety of transport problems. Each problem has been treated individually and any change in the geometry of the medium or energy distribution of the neutrons has called for a new investigation. The present paper discusses a general method of dealing with many such cases. A single formula is developed which covers most of the problems considered in past work and leads to new results. A few specializations are indicated. 8 pp. Illus. See also P-839, P-976, P-996, P-1102, P-1252, P-1390, and T-63. Superseded by P-1495.

P-1382. Book review: Bruce Netschert, *The future supply of oil and gas*. Harold Lubell. 6-4-58. Unclassified.

A review of Bruce Netschert's *The Future Supply of Oil and Gas: A Study of the Availability of Crude Oil, Natural Gas, and Natural Gas Liquids in the United States in the Period through 1975*, which shows a consistent set of domestic-supply projections as part of an investigation by Resources for the Future of the energy position of the U.S. through 1975. The main theoretical contribution of the book appears to be a severe critique of the decline-curve technique of forecasting national production from ultimate reserves estimated in terms of current technology. One criticism made of the book is that the author has been so diffident in distilling his own conclusions out of the literature that it is difficult for the reader to find, in several instances, exactly where or how he reached them. 4 pp. Table. Published in *Middle Eastern Affairs*, December, 1958.

P-1384. A vulnerability model for weapon sites with interdependent elements.
S. I. Firstman. 3-18-60. Unclassified.

A description of a simple "counting" model, using overlays and probability grids, which aids in determining the tradeoff, measured in survival probability, between site dispersal and hardening for a weapon complex composed of several interdependent elements, separated by distances of less than two lethal radii. The survival-probability expressions are obtained through the use of Markov chains. An example of vulnerability estimation by the use of the model is included. 27 pp. Illus. Published in *Operations Research*, March-April, 1959. Presented before the Operations Research Society of America at Palo Alto, California, August 29, 1958.

● **P-1385. Re-interpretation of the solution concept for "non-cooperative" games.**
T. C. Schelling. 6-2-58. Unclassified.

A discussion of coordination-game theory, suggesting that the "solution in the strict sense" of a tacit non-zero-sum game is to be understood largely by reference to its signalling qualities. Since other sources of signals may be present even in the purely mathematical formulation of the game, the particular qualities of the "solution in the strict sense" are but one of many potential determinants of a "rational solution." It is an empirical question—not a matter of deduction a priori—of what signals can be appreciated. A theory is neither a good normative theory nor a good descriptive theory if players can consistently do better than the theory predicts by using rational process that the theory cannot recognize. 17 pp. Illus. Incorporated in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25.

P-1386. For the abandonment of symmetry in the theory of cooperative games.
T. C. Schelling. 5-29-58. Unclassified.

An argument that the pure "moveless" bargaining game (analyzed by Nash, Harsanyi, Luce, Raiffa, and others) may not exist or, if it does, is of a different character from that generally supposed. In addition, it is argued that symmetry in the solution of bargaining games cannot be supported on the notion of "rational expectations." The point of departure for this argument is the operational identification of irrational expectations. 29 pp. Published in *The Review of Economics and Statistics*, August, 1959. Incorporated in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25.

P-1387. Space flight trajectories, navigation, and maneuvers. R. W. Buchheim.
5-16-58. Unclassified.

A discussion of space-flight trajectories and types of flight, with special attention to operation in an earth-moon environment. 45 pp. Illus. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, May 13, 1958.

P-1388. The Soviet ballistic missile and space flight program. F. J. Krieger. 6-2-58.
Unclassified.

An investigation of the Soviet ballistic missile and space flight program from the organization of the GIRD (Group Studying Reactive Motion) in 1929 to the present time. The paper discusses the exploitation of the German rocket powerplants and guidance and control equipment after World War II, the upper-atmosphere research-rocket program traced to 1949, the existence of an official Soviet space-flight program around 1953, the Soviet announcement of a successful test of an ICBM in 1957, and the activities of the present Soviet program in terms of the theoretical minimum-space-flight-velocity requirements and of the type of mission to be accomplished. 12 pp. Published in *Astronautics*, November 1958.

P-1389. Power in space. J. H. Huth. 5-26-58. Unclassified.

A discussion of possible sources of electrical power for space-flight applications. Power sources indigenous to space, including solar thermal energy, as well as packaged power units are considered. 13 pp. Tables. Published in *Astronautics*, October, 1958.

P-1390. Invariant imbedding and generalized transport theory: a basic stochastic functional equation. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 6-3-58.
Unclassified.

An extension of the application of the principle of invariant imbedding to include transport processes involving both deterministic and stochastic interaction, general geometries, and the

determination of characteristic functions and probabilities as well as fluxes. 6 pp. Illus. Superseded by P-1495. See also P-839, P-976, P-996, P-1102, P-1252, P-1380, and T-63.

P-1391. Nuclear energy in the USSR. Arnold Kramish. 5-23-58. Unclassified.

A discussion of a pattern of Soviet nuclear achievement. The USSR seeks, at the minimum, to be bigger than the West, possibly sacrificing quality for magnitude. However, the country's development of an appreciation for quality and for immense cadres of talented and imaginative junior research personnel represents the real threat to Western scientific superiority. 9 pp. Published in *Business Atomic Report—Supplement*, Vol. 4, No. 6, 1958.

P-1392. The solutions of a symmetric market game. L. S. Shapley. 6-5-58. Unclassified.

An attempt to determine solutions for a symmetrical market game in which the value of a coalition is assumed to be proportional to the number of buyers or sellers participating, whichever is smaller. 30 pp. Illus. Published in the *Annals of Mathematics Studies*, No. 40, 1959.

- **P-1393. Some information-theory considerations in space communications.** Peter Swerling. 2-24-58. Unclassified.

A discussion (in the special context of space communication) of the manner in which the capacity of a communication channel to transmit information is affected by received signal power, system bandwidth, and noise level. Examples are given of minimum power requirements for various possible space-communication tasks. 16 pp. Illus. See also P-1394. A reprint of Lecture 14 of RAND's space-flight course, "An Introduction to Astronautics."

- **P-1394. Communications in space operations.** C. M. Crain and R. T. Gabler. 2-24-58. Unclassified.

A discussion of space communication problems with special reference to systems which have one end of the link on the earth's surface. It appears that satisfactory solution of problems of communication with space vehicles at lunar distances or beyond may be difficult and expensive even when the rate of information transmission is relatively small by current standards. 16 pp. Illus. See also P-1393. A reprint of Lecture 15 of RAND's space-flight course, "An Introduction to Astronautics."

P-1395. Piston theory applied to strong shocks and unsteady flow. J. L. Raymond. 6-5-58. Unclassified.

An application of piston theory to strong shocks and unsteady flow. A biconvex airfoil is selected to illustrate limited computational results. 10 pp. Published in the *Journal of Fluid Mechanics*, August 1960.

- **P-1396. Some statistical methods of potential value in radio wave propagation investigations.** W. C. Hoffman. 6-18-58. Unclassified.

A description of certain statistical theories and techniques which possess considerable potential value for radio propagation research. These include the Kolmogorov-Smirnov statistics for testing goodness-of-fit, the statistical theory of extreme values, and the compound Poisson distribution and certain related stochastic processes. 36 pp. Illus. Presented before the Symposium on Statistical Methods in Radio Wave Propagation, held at the University of California at Los Angeles, June 18-20, 1958.

P-1397. Comments on Technological policy and economic calculation in Soviet industry, by David Granick. R. H. Moorsteen. 10-24-58. Unclassified.

A discussion of Professor Granick's attempt to determine whether the observed technological decisions in the Soviet Union are similar to those derived from economic calculation. It is assumed that such calculation is based on prices appropriate to relative factor scarcities in the economy and to demand schedules reflective of the desires of those exercising effective demand. 9 pp. Incorporated in *Value and Plan, Economic Calculation and Organization in Eastern Europe*, ed. by Gregory Grossman, published by the University of California Press, Berkeley and Los Angeles, California, 1960. \$7.00. Presented before the Symposium on Economic Calculation and Organization in Eastern Europe, held at the University of California at Berkeley, June 17, 1958.

P-1398. Comments on Wiles' *Rationality, the market, decentralization, and the territorial principle*. N. M. Kaplan. 7-7-58. Unclassified.

A discussion of the theory of the rational allocation of resources and of the meaning of rationality. Possible conflicts between a rational allocation of resources and economic growth are enumerated. In addition, some problems of proper incentives, tests of performance, and criteria for investment choice are stated. 10 pp. Incorporated in *Value and Plan, Economic Calculation and Organization in Eastern Europe*, ed. by Gregory Grossman, published by the University of California Press, Berkeley and Los Angeles, California, 1960. \$7.00. Presented before the Symposium on Economic Calculation and Organization in Eastern Europe, held at the University of California at Berkeley, June 16, 1958.

P-1400. Disengagement. Hans Speier. 11-18-58. Unclassified.

Part of a broader investigation concerned with the crisis in our national security. Disengagement, a term frequently used to designate certain proposals for change in our foreign policy, is discussed as a means of overcoming our security crisis and as a form of indirect rollback. Current political proposals for disengagement are examined, together with the pros and cons of the Rapacki plan for denuclearization of parts of Central and Eastern Europe. 11 pp. Presented before the RAND Board of Trustees at Santa Monica, California, April 10-12, 1958.

P-1401. Increasing the capacity of a network: the parametric budget problem. D. R. Fulkerson. 6-12-58. Unclassified.

A study concerned with allocating a budget of resources among the links of a network to increase its flow capacity relative to given sources and sinks. On the assumption that the cost of increasing each link capacity is linear, a labeling algorithm is described that permits rapid calculation of optimal allocations for all budgets. 24 pp. Illus. Published in *Management Science*, July, 1959.

P-1402. Satellite weather reconnaissance. S. M. Greenfield and W. W. Kellogg. 6-12-58. Unclassified.

A discussion of various aspects of weather reconnaissance by satellites, including limitations, capabilities relative to present methods, and growth potential. In addition to providing assistance in the forecasting of daily weather, future satellites may aid in improving the operational assistance provided by the weather services. 20 pp. Illus. Published in *Astronautics*, January, 1959.

P-1403. VHF and UHF communication antennas. J. F. Byrne (Motorola, Inc.) and E. Bedrosian. 6-12-58. Unclassified.

A discussion of possible antenna designs for mobile two-way communication systems to be used in land mobile service and in the coastwise and inland maritime service. 48 pp. Illus. Incorporated in *Antenna Engineering Handbook*, ed. by Henry Jasik, published by McGraw-Hill Book Company, Inc., New York, 1961. \$22.00.

P-1404. On the rank of a certain set of equations. David Gale. 6-13-58. Unclassified.

A study concerned with a certain well-known set of $6n^2$ linear equations in n^4 unknowns whose non-negative integral solutions are in one-to-one correspondence with pairs of orthogonal n th order Latin squares. It is shown that the rank of this system is $6n^2 - 8n + 3$. 8 pp.

P-1405. The anatomy of deterrence. Bernard Brodie. 6-13-58. Unclassified.

A discourse on the strategy of deterrence and of the related principle of limiting to tolerable proportions whatever conflicts become inevitable. The conceptions of deterrence and of limited war take into account the fact that the United States is a status quo power and that there are enormous American cultural resistances to hitting first in a period of threatened total war. Other topics discussed are (1) deterrence strategy versus win-the-war strategies: the sliding scale of deterrence; (2) deterrence and the choice of bombing vehicles: missiles versus aircraft; (3) the problem of target choice in retaliation; (4) the choice of weapons for maximum deterrence; (5) deterrence and civil defense; and (6) deterrence and armaments control. 31 pp. Also published as RM-2218. Published in *World Politics*, January, 1959. Incorporated in *Strategy in the Missile Age*, Princeton University Press, Princeton, New Jersey, 1959. \$6.50.

● **P-1406. Experiments in interplanetary biomigration and space contamination.** I. Cooper and A. G. Wilson. 6-16-58. Unclassified.

A discussion of certain preliminary experiments and precautions that should be undertaken with existing satellite and space-flight capabilities in preparation for subsequent space biological research.

The types of experiments considered are designed to determine the survival of micro-organisms under various atmospheric and space conditions, the astrophysical properties of micro-organisms, and the presence (if any) of micro-organisms by actual samples taken at various levels of the atmosphere and exosphere. 12 pp. Presented before the Symposium on Possible Uses of Earth Satellites for Life Sciences Experiments at Washington, D.C., May 14-17, 1958.

P-1407. On the rotational motion of a body re-entering the atmosphere. T. B. Garber. 3-10-59. Unclassified.

A formulation of the exact equations of motion of a body acted on by aerodynamic and gravitational forces, using inertial axes fixed in a spherical, nonrotating earth. After considering the nature of a typical re-entry path, the equations of motion are linearized. Solutions of the linearized equations are then obtained by the use of a modified WKBJ approximation method. 34 pp. Illus. Published in the *Journal of the Aerospace Sciences*, July 1959.

P-1408. Invariant imbedding and neutron transport theory—III: neutron-neutron collision processes. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 6-20-58. Unclassified.

A study of neutron transport models in which collisions between neutrons, as well as other types of collisions, are considered. The concept of invariant embedding is used to derive the functional equations which constitute a mathematical description of the physical processes. Under certain conditions it is shown that neutron-neutron collisions prevent the occurrence of a critical mass, just as viscosity effects can smooth out shock waves in compressible fluid flow. 24 pp. Illus. Published in the *Journal of Mathematics and Mechanics*, March, 1959.

P-1409. Lunar rays: their formation and age. L. A. Giamboni. 6-20-58. Unclassified.

A discussion of the nature of the rays of Tycho and Copernicus which suggests that they were laid down at a time when the angular velocity of the moon was markedly different from that observed today. The rays of Tycho indicate that the lunar sidereal period was between 0.5 and 6.8 days and that the poles were in approximately the same position then as they are today. These rays were created within 80 million years of the time the moon was formed. The rays of Copernicus support these observations and indicate that the rotation of the moon at the time these rays were formed was similar to the rotation which existed at the time Tycho was formed. 39 pp. Illus. Published in *The Astrophysical Journal*, July, 1959.

P-1410. On integer and partial integer linear programming problems. G. B. Dantzig. 6-20-58. Unclassified.

A study concerned with solving a linear program in which some variables must have integer values. If the integer condition is ignored, the linear-programming solution often yields integer solutions and the problem is solved. However, if the solution turns out fractional, it is necessary to add additional linear constraints and to repeat the procedure until an integer solution is achieved. A recent result of R. E. Gomory showed how to add additional constraints if all variables must have integer values. The present paper discusses the partial integer problem and extends Gomory's procedure to the case in which all but one variable must have integer values. 9 pp.

● **P-1411. The failures of the world bank missions.** F. T. Moore. 5-5-60. Unclassified.

A critique of the mission reports of the International Bank for Reconstruction and Development which present information on the problems and characteristics of the underdeveloped economies of some fifteen countries. The author found this material unsatisfactory as economic analyses and unsuitable in areas of statistics, development program outlines, project delineation, surveying the real alternatives open to the country, price effects of development programs, and private vs. public investment. 50 pp. Table. Published under the title, "The World Bank and Its Economic Missions," in *The Review of Economics and Statistics*, February 1960.

P-1413. Top management decision and simulation processes. R. E. Bellman. 6-26-58. Unclassified.

An exposition of some of the general problems in constructing a simulation process, and of some of the ideas that can be used to treat these problems. 24 pp. Published in *The Journal of Industrial Engineering*, September-October, 1958. Presented before the American Institute of Industrial Engineers at Los Angeles, California, June 12, 1958.

P-1415. A first experiment in logistics system simulation. M. A. Geisler. 7-1-59.

Unclassified.

An over-all picture of Laboratory Problem I, which tested a series of proposed changes to the Air Force supply system. Such aspects are discussed as the experimental design of LP-I, various policies, the preparations for the Laboratory run, the operation of LP-I, peacetime results, the LP-I war, and Laboratory management experience. The experiment indicated that the logistics system containing the newer supply policies was better and that this type of simulation developed many more insights into the operation of proposed policies than traditional analytical techniques provide normally. 50 pp. Illus. Published in the *Naval Research Logistics Quarterly*, March 1960.

P-1416. Dynamic programming and adaptive processes—I: mathematical foundation.

R. E. Bellman and R. E. Kalaba. 2-6-59. Unclassified.

A basis for the mathematical treatment of adaptive processes (a class of decision processes) through use of dynamic programming concepts. These processes arise in statistical studies, in the field of operations research, in stochastic control processes, and in problems of communication theory. Independently, theories governing the treatment of adaptive processes are essential for developing automata and machines that learn. Subsequent papers will consider specific applications. 25 pp. See also RM-2189, P-1223, and P-1500. Published in the *IRE Transactions on Automatic Control*, January 1960.

P-1417. On k th best policies. R. E. Bellman and R. E. Kalaba. 2-26-60. Unclassified.

A proof that the functional-equation technique of dynamic programming can be used to determine the optimal, second-best, third-best, etc., policies for various deterministic and stochastic multistage decision processes. This proof is significant in various problems in combinatorial analysis, network and switching theory, and sensitivity analysis. The routing problem is also discussed. 14 pp. Published in the *Journal of the Society for Industrial and Applied Mathematics*, December 1960.

P-1418. Bounds on the expectation of a convex function of a multivariate random variable. Albert Madansky. 7-30-58. Unclassified.

A derivation of the upper and lower bounds on the expectation of a convex function of a vector-valued random variable by examining the boundary of an appropriate multivariate moment space. The bounds obtained are also improved. 13 pp. Published in *The Annals of Mathematical Statistics*, September, 1959.

P-1419. Broken gems and whole tiles: a review article. A. M. Halpern. 8-8-58. Unclassified.

A review of two books from a sociological viewpoint, with emphasis on the explanatory concepts used by the authors and what these concepts explain. *Control of Japanese Foreign Policy: A Study of Civil-Military Rivalry, 1930-1945* by Y. C. Maxon discusses the process by which the military in prewar Japan gradually achieved a working monopoly of the power of decision in foreign affairs and how the power was finally regained by civilian authority. *The United States and Japan* by E. O. Reischauer deals with Japanese history, geography, and character, and several postwar sociopolitical developments. 9 pp. Published in *World Politics*, January, 1959.

● **P-1420. Materials for space flight.** G. A. Hoffman. 7-1-58. Unclassified.

A discussion of the spectrum of thermal environments and functional requirements for materials used in space vehicles. A desire by designers to operate materials at the highest permissible temperature and the necessity to minimize the structural weight are two major criteria considered. Future possibilities in materials are investigated: For maximum temperatures the metals, carbon, and carbides are studied, while for minimum-weight requirements fibered materials for tension elements, and beryllium for buckling components, are discussed. Improvements in performance of space-flight vehicles are listed, and topics for research in each material area are presented. 26 pp. Illus. A reprint of Lecture 7 of RAND's space-flight course, "An Introduction to Astronautics." Presented at the Space Exploration Meeting at San Diego, California, August 5, 1958.

P-1421. Middle East crises and world petroleum movements. Harold Lubell. 7-8-58.

Unclassified.

A discussion of the major interruptions in the supply of oil from the Middle East in Iran in 1951 and at Suez in 1956. The resulting shipping crises were met by reorganization of the tanker facili-

ties of the western international oil companies. This study surveys the effects of these crises on world petroleum production and shipping, and examines the impact of a hypothetical future interruption of the flow of Middle Eastern oil to the Western world. 33 pp. Tables. A revision of RM-2185. Published in *Middle Eastern Affairs*, November, 1958.

P-1422. Semigroups of class (C_0) in L_p determined by parabolic differential equations. T. W. Mullikin. 1-9-59. Unclassified.

An application of the semigroup theory of E. Hille and R. S. Phillips to mixed initial-boundary value problems for nonsingular parabolic differential equations in two variables. 27 pp. Published in the *Pacific Journal of Mathematics*, Fall, 1959.

P-1423. Use of tolerance limits in missile evaluation. Albert Madansky. 4-20-59. Unclassified.

A presentation of a use of tolerance limits in reliability analysis. Tolerance limits for normal and exponential distributions are given, as well as nonparametric tolerance limits. The latter are compared with the parametric limits, and further properties of the parametric limits are discussed. 15 pp. Presented before the Symposium on Statistical Techniques in Missile Evaluation at Blacksburg, Virginia, August 6, 1958, and published in the proceedings of the Symposium.

● **P-1424. An econometric study of aircraft malfunction behavior.** V. L. Smith. 8-15-58. Unclassified.

The results of a study of the malfunction behavior of certain Air Force aircraft equipment, with particular emphasis on the problem of prediction. Several approaches to the study of malfunctions, the malfunction behavior of jet engines, and the identification problem in aircraft malfunction models are discussed, and a "complete" model of aircraft malfunction behavior is constructed. Although this application is to a specific type of Air Force hardware, the methodology and many of the general empirical findings may be relevant to other kinds of complex capital equipment. 25 pp. Illus.

P-1425. Prologue to a syntax of space exploration. A. G. Wilson. 7-15-58. Unclassified.

A paper presented before the Second Lunar and Planetary Exploration Colloquium, held at RAND on July 15, 1958, and published in the proceedings of the Colloquium. The author discusses the problem of achieving a unified, scientifically responsible program, or syntax, for space exploration, and suggests that in addition to setting up a systematic approach to acquire new facts, the syntax of space exploration should seek the detection of presently unknown parameters. 11 pp.

P-1426. Some remarks on the nature and origin of noctilucent cloud particles. D. Deirmendjian and E. H. Vestine. 7-18-58. Unclassified.

An analysis, after accounting for the selective attenuation of the lower atmosphere and the spectrum of sunlight, of recently obtained continuous spectra of the light from noctilucent clouds. It is found that the spectra may be explained in terms of the simple scattering of direct sunlight by minute dielectric particles with a maximum radius of 0.4 micron. 21 pp. Illus. Published in *Planetary and Space Science*, April, 1959. Presented before the Fifth Meeting of the Special Committee for the International Geophysical Year at Moscow, USSR, July 30–August 9, 1958, and before a Department of Meteorology Seminar at the University of California at Los Angeles, March 2, 1959.

● **P-1427. The space environment.** A. G. Wilson. 2-24-58. Unclassified.

A review of present astronomical knowledge concerning the solar system, with emphasis on facts which may be of importance to the astronaut. The basic difference between space environment and terrestrial environment is examined, and the material content of space that may offer a collision threat to a space vehicle is discussed. 23 pp. Illus. A reprint of Lecture 2 of RAND's space-flight course, "An Introduction to Astronautics."

● **P-1428. Types of space flights.** R. W. Buchheim. 2-24-58. Unclassified.

A discussion of the trajectory characteristics of three general categories of space flight: earth-satellite missions, lunar missions, and interplanetary missions. 32 pp. Illus. A reprint of Lecture 4 of RAND's space-flight course, "An Introduction to Astronautics."

- **P-1429. Propulsion fundamentals.** Benjamin Pinkel. 2-24-58. Unclassified.
A discussion of the basic principles of operation of reaction propulsion systems. The characteristics of various types of propulsion systems are described, namely, liquid-propellant systems, solid-propellant systems, and nuclear systems. 32 pp. Illus. A reprint of Lecture 5 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1430. Orientation and control.** T. B. Garber. 2-24-58. Unclassified.
A discussion of various methods of establishing the attitude of a space vehicle with respect to a self-contained reference system and of controlling the vehicle's orientation if errors arise. 26 pp. Illus. A reprint of Lecture 13 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1431. Space-flight ground-facility-requirements problems: launching facilities.** J. J. O'Sullivan. 2-24-58. Unclassified.
A discussion of the launching facilities for large rockets such as those that will be required for space flight. The need for early and continued cooperation between designers of the rockets and designers of ground-handling equipment is stressed. 14 pp. Illus. A reprint of Lecture 19 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1432. Interplanetary exploration.** A. G. Wilson. 2-24-58. Unclassified.
A guidebook for those attempting early exploration of the planets in our solar system. Emphasis is placed on the need for measuring the fundamental astronomical units of distance in terms of laboratory standards of length. 15 pp. Table. A reprint of Lecture 22 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1433. Some elementary facts of relativity.** H. A. Lang. 2-24-58. Unclassified.
Data necessary for evaluating space-travel proposals, involving relativistic mechanics. The contraction factor γ is determined, by means of which relativistic equations of "communication" are derived between two hypothesized systems, A and B. Various effects connected with the fact that these two systems are separating at a constant velocity are explained. The so-called clock or twin paradox is resolved by demonstrating that the paradox does not exist when general relativity is introduced to relate the time intervals for two events occurring in different gravitational fields. 20 pp. Illus. A reprint of Lecture 23 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1434. Outer space and international law.** L. S. Lipson. 2-24-58. Unclassified.
A review of the present status of international air and maritime law and its possible applications and extensions to cover outer space. The present status of "space law" is analyzed with special attention to Soviet views. 27 pp. A reprint of Lecture 24 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1435. Some political implications of the space age.** J. M. Goldsen and L. S. Lipson. 2-24-58. Unclassified.
A discussion of the recent advent of activities in outer space in relation to the basic political struggle on the planet Earth. Current Soviet political strategy is analyzed, followed by some considerations for framing United States objectives. 18 pp. A reprint of Lecture 25 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1436. Lunar-base planning considerations.** R. D. Holbrook. 2-24-58. Unclassified.
An examination of the kind of operation implied by the concept of a lunar base, the surface conditions to be expected on the moon, and the planning factors for establishing an independent base. 28 pp. Tables. A reprint of Lecture 30 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1437. Soviet astronautics.** F. J. Krieger. 2-24-58. Unclassified.
A description of the long and active history of Soviet interest in space flight leading up to the launching of Sputniks I and II. A discussion of Soviet technical and popular literature on space flight is included. 31 pp. A reprint of Lecture 32 of RAND's space-flight course, "An Introduction to Astronautics."
- **P-1438. Food preservation.** J. H. Huth. 2-24-58. Unclassified.
A review of three food preservation methods that may have application to space flight. The methods treated are γ irradiation, β irradiation, and freeze drying. It is indicated that the last method may

provide both a long storage life (unrefrigerated) and a very lightweight product without adversely affecting vitamins or protein structure. 19 pp. A reprint of Lecture 34 of RAND's space-flight course, "An Introduction to Astronautics." Incorporated in *Space Handbook, Astronautics and Its Applications*, published by Random House, Inc., New York, 1959. \$3.95.

- P-1439. Social charges in the EEC countries: some economic aspects. M. W. Hald. 7-22-58. Unclassified.

A discussion concerned with the economic aspects of "social charges," defined as the costs to employers of the fringe elements of worker remuneration, namely, bonuses and gratuities, payments in kind, payment for time not worked, obligatory social security contributions, non-obligatory social security contributions, direct benefits paid to workers, and subsidies of various services for the benefit of the worker. The study is confined to the possible economic effects of these charges to countries of the European Economic Community. Some possible effects of the development of social charges are explored, and some areas for future research are indicated. 29 pp. Published in *Economia Internazionale*, November 1959.

- P-1440. On a Liouville transformation for $u_{xx} + u_{yy} \pm a^2(x,y)u = 0$. R. E. Bellman. 7-22-58. Unclassified.

A proof that the equation $u_{xx} + u_{yy} \pm a^2(x,y)u = 0$ may be reduced to the form $u_{ss} + u_{tt} \pm u = 0$ by a change of variable of the form $s = s(x,y)$, $t = t(x,y)$, provided $\log a(x,y)$ is a harmonic function. 8 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 13, No. 3, 1958.

- P-1441. Circumlunar trajectory studies. H. A. Lieske. 6-25-58. Unclassified.

The use of a simplified model of the earth-moon system to investigate various possible classes of unpowered circumlunar trajectories. The development of these trajectories is shown, using the initial conditions for lunar impact trajectories as a reference. The parameters of the trajectory in the vicinity of the moon and on return to the earth are discussed as functions of the initial conditions, and representative tolerance values are given. Typical examples of trajectories are shown. 25 pp. Illus. Presented before the Space Exploration Regional Meeting, sponsored jointly by the Institute of Aeronautical Sciences and the American Rocket Society, at San Diego, California, August 5, 1958.

- P-1442. Some aspects of astronautics. R. W. Buchheim, S. Herrick, E. H. Vestine, A. G. Wilson, and P. Swerling. 7-23-58. Unclassified.

A discussion of some aspects of astronautics, including space environment, basic laws of celestial mechanics, orbital elements, perturbations and precision, lunar and interplanetary flights, and experimentation in space. 48 pp. Illus. Published in the *IRE Transactions on Military Electronics*, December, 1958.

- P-1443. Space communications. Peter Swerling. 7-23-58. Unclassified.

A discussion of communications in space from the standpoint of the general lines of research and development needed for operation in a space environment. Space communications is defined as the design and use of communication equipment for space-flight applications. The author concludes that in all probability, the most important novel interactions between communications and space flight are unpredictable at present. 15 pp. Table. Published in the *IRE Transactions on Military Electronics*, December, 1958.

- P-1444. A table for obtaining trial values for estimating relationships in which the dependent variable is limited. R. N. Rosett. 7-24-58. Unclassified.

The title of this publication describes its aim and content. 3 pp. Table.

- P-1445. Review of OEEC, *Some aspects of the European energy problem*, and OEEC, *Europe's growing needs of energy: how can they be met?* Harold Lubell. 7-28-58. Unclassified.

A review of two documents showing the basic contributions of the Organization for European Economic Cooperation to the discussions of Western Europe's growing shortage of energy resources that preceded the birth of Euratom. *Some Aspects of the European Energy Problem*, written in 1955 by Louis Armand, deals with economic aspects of energy production, atomic energy, and traditional sources of energy. *Europe's Growing Needs of Energy: How Can They Be Met?* written in 1956 by a group of experts, considers several other aspects of the energy problem (namely,

the projection of demand and indigenous supply of energy from 1955 to 1960 and 1975, possibilities of improved efficiency of energy use, investment needs, balance of payments effects, and the question of prices). 5 pp.

P-1446. Multiple image printing for planetary photography. D. S. Kirby. 7-25-58. Unclassified.

A discussion of the multiple-image printing method for making photographs of planets. This method offers a means of minimizing loss of detail caused from atmospheric blurring, the motion of the object being studied, and the limitations of the photographic process. 16 pp. Illus. Published in the *Publications of the Astronomical Society of the Pacific*, August 1959.

P-1447. Dynamics of the Moscow-Peking axis. A. S. Whiting. 9-29-58. Unclassified.

An examination of the developments in the alliance between the Soviet Union and Communist China. The paper discusses (1) the dependence of Peking upon Moscow during the Stalin period, (2) the increased leverage during the post-Stalin era when Peking intervened in bloc affairs in 1956, and (3) the abandonment of this formula in November, 1957, with a shift by Mao Tse-tung to a harsher line both on bloc affairs and toward the noncommunist world. The change in Peking policy from 1956 to 1957 may have resulted from a reappraisal of Soviet strength, consequent from ICBM and artificial satellite developments in the latter half of 1957. 29 pp. Published in *The Annals of the American Academy of Political and Social Science*, January, 1959.

P-1448. An equivalent linear-programming problem. G. B. Dantzig and S. M. Johnson. 8-1-58. Unclassified.

The development of an equivalent formulation for a standard linear-programming problem. For the case where the number of variables is twice the number of equations m , the equivalent problem has the same size but has the inverses of the first and second m columns of the matrix of coefficients. 8 pp.

P-1449. Costs and outputs. Armen Alchian. 9-3-58. Unclassified.

Propositions designed to eliminate some of the ambiguities and errors involved in the relationships between cost and output both in the long and short run. The suggested propositions are shown to be empirically valid in distinguishing between rate and quantity of output, the changes in technology as distinct from changes in technique, the use of calendar-time dates of output instead of technical fixity for distinguishing output operations, and the use of capital-value concepts instead of rates of costs. 28 pp. Illus. See also P-2448. Published in *The Allocation of Resources*, ed. by Paul Baran, Tibor Scitovsky, and E. S. Shaw, Stanford University Press, Stanford, Calif., 1959. \$5.00.

● **P-1450. Soviet state planning and forced industrialization as a model for Asia.** Oleg Hoeffding. 8-4-58. Unclassified.

An appraisal of the relevance and applicability to Asia's problems of Soviet experience in rapid industrialization under state planning. To profit from Soviet planning experience, Asian countries must accept the entire formula of Soviet-type totalitarianism. Alternatively, if they reject coercive methods, they must seek different paths to economic development, and it is doubtful that they can derive much benefit from copying specific technical features of Soviet planning. Most Asian countries cannot afford to concentrate on rapid industrialization to the neglect of other economic sectors, notably agriculture. They face numerous handicaps which the USSR did not have to overcome. China's experience suggests that even industrialization spurred to the utmost by Soviet-style coercive techniques will not solve her employment problem. 30 pp. Published in *Problems of Communism*, November-December 1959. Presented before the Second International Sovietological Conference at Bad Aussee, Austria, September 20, 1958.

● **P-1451. Isobars and antipodes.** J. W. T. Youngs. 8-5-58. Unclassified.

A study concerned with the size of isobars which, on any typical weather map of the world, appear usually as small closed curves around a low or a high pressure area, while they appear to be very long between low and high pressure areas. This paper shows that some isobars must be long enough to contain an antipodal pair of points. The proof is deceptively short and simple, a condition brought about by the use of some of the most powerful tools in topology. 7 pp.

P-150

P-1452-RC. Indonesian images of their national self. G. J. Pauker. 8-1-58. Unclassified.

A study based on entries to a contest (organized in March, 1957, by Mr. Soedjatmoko, managing director of the publishing house and chain of bookstores called "Pembangunan") to determine the Indonesians' images of their national self. Analysis of the material is based primarily on personal judgment about the relative importance and meaningfulness of the various entry statements. The composite image obtained was, by and large, realistic. Although self-confidence and optimism about Indonesia's future place in the world were presented, the mounting difficulties that the country was facing in the eighth year of independent existence were reflected. 57 pp. See also RM-2619-RC, RM-2637-RC, and P-1514-RC. Published in *The Public Opinion Quarterly*, Fall 1958.

P-1453. Lunar flight dynamics. R. W. Buchheim and H. A. Lieske. 8-6-58. Unclassified.

A survey of lunar flight with particular reference to flight trajectories. The general nature of the trajectory problem, classes of trajectories, initial conditions, and sensitivities to initial conditions are discussed. In addition, orientation control and launching requirements are considered. 62 pp. Illus.

• **P-1454. The simulation laboratory as a developmental tool.** W. H. McGlothlin. 8-7-58. Unclassified.

An attempt to describe the several types of simulation techniques used at RAND (namely, heuristic games, simulation which estimates quantitative solutions, developmental simulation, simulation to provide a prototype or feasibility demonstration, and simulation for training purposes). In addition, the author outlines how these methods may be used to study a complex system. 17 pp. Illus. See also P-1456 and P-1457. Presented before the American Psychological Association at Washington, D.C., August 28–September 3, 1958.

P-1456. Simulation in RAND's Logistics Systems Laboratory: Laboratory Problem I. W. W. Haythorn. 9-3-58. Unclassified.

A description of the cost-effectiveness results of Laboratory Problem I, an attempt to simulate and compare two large logistics systems, identical except for the policies governing them and the resulting differences in resources. The deferred procurement policy is shown to save the Air Force a considerable amount of money at not much loss in effectiveness, but at some risk of higher AOCF rates for some parts. 18 pp. Tables. See also P-1454 and P-1457. Presented before the American Psychological Association at Washington, D.C., August 28–September 3, 1958.

P-1457. Communications analysis in LP-I. R. S. Beverly. 8-11-58. Unclassified.

A study of the communication between participants in the Logistic Systems Laboratory's first project. The classes of information discussed are communication from the experimental personnel to the computer and the information communicated via telephone or memo by the participants. The data presented describe a technique for measuring group behavior that permits predictions and the testing of hypotheses about simulated organizational behavior. 21 pp. Illus. See also P-1454 and P-1456. Presented before the American Psychological Association at Washington, D.C., August 28–September 3, 1958.

• **P-1458. A rational economic model approach to the birth rate.** Bernard Okun. 8-12-58. Unclassified.

The use of a rational maximization model approach to formulate an economic theory of the birth rate. The model attempts to explain why planned family size has declined over time despite a secular rise in income. It suggests that the rise in income has resulted in a secular rise in the level of living of children, making children relatively more expensive than commodities, and thereby inducing couples to substitute commodities for children. 12 pp. Illus. Presented before the Econometric Society at Philadelphia, Pennsylvania, August 28, 1958.

P-1459. Solving two-move games with perfect information. G. B. Dantzig. 8-11-58. Unclassified.

A study of a two-move game with perfect information, such as a move and countermove situation between two firms or economies. This leads to the problem of finding a global minimum of a concave function over a convex domain and the distressing possibility of local minima at every

extreme point. It is shown, however, that the global minimum can be obtained by solving a linear-programming system, with side conditions that at least one of certain pairs of variables vanish. The latter problem can be shown to be equivalent to solving a linear-programming problem with some integer-valued variables. 7 pp.

P-1460. Earth-period (24-hour) satellites. J. H. Hutcheson. 2-23-59. Unclassified.

A discussion of the relative motion between the earth and an earth-period satellite where the orbital plane is inclined, the motion is elliptical, and perturbations from the moon, sun, and earth's oblateness are considered. An earth-period satellite is one which has an orbital period of rotation exactly to the earth's period of rotation on its axis. The term implies an idealized equatorial and circular orbit where no relative motion exists between the earth and satellite. Several illustrations are given showing the effect of various different orbital parameters on the satellite ground track, and some possible practical uses are mentioned. 20 pp. Illus. Published in the *ARS Journal*, November, 1959.

P-1461. A review of OEEC, *Oil: the outlook for Europe*, and OEEC, *Europe's need for oil: implications and lessons of the Suez crisis*. Harold Lubell. 8-15-58. Unclassified.

A review of the last two reports of the Oil Committee of the Organization for European Economic Cooperation. These publications constitute the best available summary of Western European views on the oil situation and reflect Europe's growing awareness of the extent of its stake in Middle East oil. *Oil: The Outlook for Europe* was published after the Egyptian nationalization of the Suez Canal, but before the Anglo-French-Israeli attack on Egypt and the subsequent closing of the Canal. *Europe's Need for Oil: Implications and Lessons of the Suez Crisis* describes what happened when the Suez Canal was closed and tanker routes were altered. 5 pp.

P-1462. Economics of defense procurement and small business. D. Novick and J. Y. Springer. 8-15-58. Unclassified.

An examination of the magnitude and nature of military procurement and of the special commercial considerations involved. The analysis deals with the economics of procurement of weapons and with the related and specialized equipment essential to their operation. The weapon systems concept of procurement management developed in the last few years is discussed, together with the national security considerations which compel a distinction between the market for these goods and that which prevails in normal commercial contracts. 23 pp. Illus. Published in *Law and Contemporary Problems*, Winter 1959.

P-1463. An application of dynamic programming to the determination of optimal satellite trajectories. R. E. Bellman and S. E. Dreyfus. 1-20-59. Unclassified.

A discussion of a simplified satellite trajectory problem, corresponding to a flat earth assumption, first treated by Okhotsimskii and Eneev. A numerical solution based on the functional-equation technique of dynamic programming is presented, together with a proof of the fundamental result in the analytic solution. The same computational approach can be applied to more realistic trajectory problems. 18 pp. Illus. Published in the *Journal of the British Interplanetary Society*, May–August 1959.

● **P-1464. Dynamic programming and the calculus of variations.** S. E. Dreyfus. 4-25-60. Unclassified.

A study showing that the functional equation technique of dynamic programming yields formal derivations of such classical necessary conditions of the calculus of variations as the Euler–Lagrange equations, the Weierstrass and Legendre conditions, natural boundary conditions, a transversality condition, and the Erdmann corner conditions. The more general “problem of Bolza”—in which the final time is defined implicitly and in which the expression to be extremized is the sum of an integral, and a function evaluated at the end point—is also considered. The principal necessary condition, usually called the “multiplier rule,” is deduced. Necessary conditions are derived for the case in which the decision variables are restricted by inequality constraints. Finally, it is shown that the functional equation characterization readily yields the Hamilton–Jacobi partial differential equation of classical mechanics. 20 pp. See also P-2357 and P-2374. Published in the *Journal of Mathematical Analysis and Applications*, September 1960. Presented before the Operations Research Society of America at Paris, France, September 9, 1960.

P-1465. A new look at experience rating. H. M. Wagner. 8-20-58. Unclassified.

An analysis of the recent developments in experience rating (provided under the Federal Unemployment Act of 1939) to evaluate suggested policy changes in the system's operation. The various arguments presented are that a potential lowering of taxes gives firms an incentive to stabilize their work force, "unstable" employers should bear more of the cost for unemployment compensation than "stable" employers, current financing is inadequate to meet possible rises in the unemployment rate, and undesirable interstate and interindustry inequities prevail. It is concluded that a diminution of experience-rating differentials, combined with a more direct cyclical scheme of varying over-all rates, will provide financial benefits outweighing those presently in effect. 20 pp. Illus. Published in the *Southern Economy Journal*, April 1959.

P-1466. A review of energy forecasts in Western Europe. Harold Lubell. 8-21-58. Unclassified.

A review of several reports concerned with projecting European energy requirements and regional deficits two decades into the future. These reports, written under the auspices of the Organization for European Economic Cooperation, the European Coal and Steel Community, and Euratom, are entitled respectively, *Europe's Growing Needs of Energy: How Can They Be Met?*, *The Structure and Trends of the Energy Economy of the Countries of the ECSC*, and *A Target for Euratom*. They are closely related by authorship, basic statistics, and methodology. 6 pp. Published in *Econometrica*, January 1960.

● **P-1467-RC. Technology and the challenge of the future.** J. C. DeHaven. 11-30-59. Unclassified.

A discourse on technology and its contributions to the desires or security requirements of society. The future of technology in relation to the possible challenges to be faced by the society in which it exists is discussed, together with the more important areas where the greatest probability for technological advance may be expected. 14 pp. Presented during the Summer Seminar Series, "The Next Fifty Years," sponsored by the University of California, at Santa Barbara, California, August 20-21, 1958. Also presented before the Committee on the Mississippi Economy at The Mississippi Industrial Research Center, Jackson, Mississippi, December 8, 1959.

P-1468. Parameter estimation for waveforms in additive Gaussian noise. Peter Swerling. 8-25-58. Unclassified.

A method for computing the greatest lower bound for the variance of unbiased estimates of waveform parameters when the waveform is observed in additive Gaussian noise. The greatest lower bound is approximately evaluated in several illustrative cases. The waveform parameters occurring in these examples are amplitude, time delay, and doppler shift. 27 pp. Published in the *Journal of the Society for Industrial and Applied Mathematics*, June, 1959. Presented before a group at Hughes Aircraft Company, Culver City, California, May 1, 1959.

P-1469. Military thought and politics in the USSR. Myron Rush. 8-26-58. Unclassified.

A commentary on Raymond Garthoff's book *Soviet Strategy in the Nuclear Age*, which constructed the pattern of Soviet military doctrine as that of victory based on balanced forces organized and coordinated for combined operations during a long war. The present document indicates that Dr. Garthoff was too preoccupied with Soviet military writings to the neglect of the views of political leaders and that the USSR has adopted a "pre-emptive" strategy, designed to hit decisive centers to end a war speedily. The author concludes that although Dr. Garthoff has not wholly succeeded in reconstructing Soviet military strategy, he has written one of the important books of our day. 10 pp. Published in *The New Leader*, January 5, 1959.

P-1470. Asymptotic behavior of solutions of differential-difference equations. R. E. Bellman and K. L. Cooke. 8-28-58. Unclassified.

An attempt to determine the asymptotic behavior of solutions of linear differential-difference equations whose coefficients possess asymptotic series. By means of a sequence of transformations, the problem is reduced to a form in which the standard techniques of ordinary differential-equation theory can be used. Although the guiding ideas are simple, the analysis becomes formidable, and for this reason, only some of the more immediate aspects of the problem are considered. 126 pp. Published in the *Memoirs of the American Mathematical Society*, 1959. \$2.00.

P-1471. Invariant imbedding and wave propagation in stochastic media. R. E. Bellman and R. E. Kalaba. 8-29-58. Unclassified.

An extension of previous results and techniques of the principle of invariant imbedding to include cases involving plane wave propagation in stochastic media. The approach considers the derivation of stochastic functional equations for reflection and transmission coefficients and the obtaining of expected values of appropriate functions of the random state variables. The particular example is discussed where a plane wave is incident on a stratified slab which is characterized by stochastic wave numbers in each stratum. 24 pp. Illus. Presented before the International Conference on Wave Propagation, Universal and International Exhibition, at Brussels, Belgium, October 6-11, 1958, and published in the proceedings of that Conference.

P-1472. The delicate balance of terror. A. J. Wohlstetter. December 1958. Unclassified.

A criticism of the popular view that deterrence of central war is easy. As a major illustration, important both for defense and foreign policy, the particularly stringent conditions are considered that forces based close to the enemy must meet to be effective deterrents. The inadequacy as well as the necessity of deterrence, the problem of accidental outbreak of war, and an aspect of disarmament are also discussed. Deterring general war in both the early and late sixties, although by no means the whole of a successful military or foreign policy, will be difficult enough. 45 pp. See also P-1877. Published in *Foreign Affairs*, January, 1959.

P-1473. The distribution of radial error and its statistical application in war gaming. H. P. Edmundson. 8-29-58. Unclassified.

A discussion of the assumptions and theorems concerning the distribution of weapon radial error and a demonstration of its statistical application in war gaming. The density function and cumulative distribution function of the radial error are derived and graphed for one, two, and three dimensions. For each of these cases, formulas are given for the expectation, standard deviation, and median of the radial error. 28 pp. Illus. Also published as RM-1744.

P-1474. The goodness-of-fit statistics of Kolmogorov and Smirnov. H. P. Edmundson. 8-29-58. Unclassified.

An examination of the goodness-of-fit statistics of A. Kolmogorov and N. Smirnov. This paper summarizes the theory and applications of these statistics and compares them with the classical χ^2 statistic for testing goodness of fit. 21 pp. Tables. Also published as RM-1820. See also P-1475 and P-1476.

P-1475. The moments of two limiting distributions of Kolmogorov. H. P. Edmundson. 8-29-58. Unclassified.

A derivation of a general expression for the i th moment of two limiting distributions due to A. Kolmogorov. The dispersions of these two distributions are then compared. 13 pp. Also published as RM-1905. See also P-1474 and P-1476.

P-1476. The moments of two distribution-free statistics of Smirnov. H. P. Edmundson. 8-29-58. Unclassified.

A derivation of a general expression for the i th moment of two distribution-free statistics due to N. Smirnov. 12 pp. Table. Also published as RM-1958. See also P-1474 and P-1475.

P-1478. A mathematical study of arbitrage. J. J. Stone and H. M. Wagner. 9-2-58. Unclassified.

A study of the mathematical structure underlying nearly perfect exchange markets spatially or temporally separated. Such questions are investigated as the equilibrium conditions for a set of exchange rates and how arbitrage possibilities are discovered and if they exist. The analysis involves the combined use of an algebraic representation—conducive to deriving qualitative features characterizing a multiexchange market—and two linear-programming models. One model is used in establishing a desirable set of equilibrium exchange rates, and the other permits an efficient computational scheme for discovering arbitrage possibilities. 42 pp. Illus.

P-1479. Some fundamental considerations relating to advanced rocket propulsion systems. J. H. Huth. 9-2-58. Unclassified.

A general relativistic theory of rocket propulsion, applicable to either adiabatic or diabatic jets and to several methods for handling fuel residual. The study emphasizes the performance limitations

imposed by both fuel energetics and power supply weight. However, the discussion is limited to constant-thrust vehicles. 18 pp. Illus. Published under the title, "Relativistic Theory of Rocket Flight with Advanced Propulsion Systems," in the *ARS Journal*, March 1960.

- **P-1480. A note on the relationship of saving to the rate of interest, real income, and expected future prices.** D. V. T. Bear. 9-4-58. Unclassified.

A refutation of the usual argument that saving and the rate of interest may be negatively related. This paper shows that using the saving-for-a-fixed-future-sum argument as support for the hypothetical negative relation between saving and the interest rate leads to nonsensical results; that a negative relation between saving and the interest rate should be put not in terms of fixed future sums, but rather in terms of the price elasticity of demand for future goods; and that if such a negative relationship exists, then the logical reaction of consumers to changes in expected future prices will be surprising. 13 pp. Illus. Published in *The Review of Economics and Statistics*, February 1961.

- **P-1481. The propagation of errors in Keplerian orbits.** R. T. Gabler and H. R. O'Mara. 8-1-58. Unclassified.

A discussion of the propagation of errors in Keplerian orbits. The error sensitivities considered are those concerned with orbital parameters and predicted position components at a point on the path as a function of position and velocity errors at some other point of observation or measurement. 44 pp. Illus. Presented before the U.S. Naval Postgraduate School at Monterey, California, October 10, 1958.

- P-1482. On the possibility of an energy gap in the spectrum of a degenerate Fermi liquid.** R. A. Ferrell. 8-29-58. Unclassified.

A proof, on the basis of Galilean invariance, that a degenerate liquid of identical interacting Fermions possesses excited states corresponding to arbitrarily small energies of excitation. Thus there is no energy gap in the spectrum of infinite nuclear matter, and there is an essential difference between nuclear matter and the electron gas in a superconductor. In the latter, the lattice provides a preferred frame of reference so that a gap in the energy spectrum is not excluded by considerations based on Galilean invariance. 11 pp. Illus.

- **P-1484. A general theorem concerning the stability of a particular non-Newtonian fluid.** S. M. Genensky. 5-20-59. Unclassified.

A proof of a theorem on the stability of a particular non-Newtonian fluid. The method used is similar to that of H. Schlichting in his proof of a similar theorem for an inviscid fluid originally established by Lord Rayleigh. The acceleration gradients introduced by the non-Newtonian-fluid model into the constitutive equations are found to alter the stability criteria expounded by Rayleigh for an inviscid fluid. 15 pp. Published in the *Quarterly of Applied Mathematics*, October 1960.

- P-1485. Multiple quadrature by Monte Carlo.** Herman Kahn. 9-5-58. Unclassified.

An application of Monte Carlo to multiple quadratures. Such an account has previously appeared in other papers, but not with so much emphasis on multidimensional integrals as in this case. An example treated is a Gell-Mann problem occurring in electron physics; its solution is given. This is primarily intended to be instructive as a first problem. 22 pp. Illus.

- P-1486. On the significance of solving linear-programming problems with some integer variables.** G. B. Dantzig. 4-9-59. Unclassified.

A discussion of recent proposals by Gomory and others for solving linear programs involving integer-valued variables. Problems that can be reduced to this class, and thereby solved, are reviewed. It is significant that the reduction can be made for problems involving multiple dichotomies and k -fold alternatives. These problems include those with discrete variables, nonlinear separable minimizing functions, conditional constraints, global minimum of general concave functions, and combinatorial problems such as the fixed-charge problem, traveling-salesman problem, orthogonal latin-square problems, and map-coloring problems. 28 pp. Illus. Published in *Econometrica*, January 1960. Presented before the Program and Game Theory Seminar at Princeton University, Princeton, New Jersey, October 15, 1958.

- **P-1488. The meaning and validity of inflation-induced business profits resulting from a lag of wages behind prices.** A. A. Alchian and R. A. Kessel. 11-6-58. Unclassified.

A discussion of the belief that inflation causes prices to rise faster than wages. Implications of this axiom are that (1) a lag of wages behind prices as a result of inflation produces extraordinarily large business profits; (2) because of these large profits, business firms ought to be heavily taxed as inflation-profiters; (3) the lag of wages behind prices caused by inflation accentuates oscillations in the general level of economic activity. The authors attempt to convert this argument into empirically meaningful propositions and to examine the meaning, empirical content, and evidence supporting these propositions. 58 pp. Tables. Published in *American Economic Review*, June 1960.

- P-1490. The cross-section method: an algorithm for linear programming.** J. J. Stone. 9-16-58. Unclassified.

An algorithm that solves the linear-programming problem. This algorithm combines the usual phase one (obtaining feasibility) and phase two (obtaining optimality) of the simplex or dual methods into a single phase. The algorithm begins with either a single activity (column) or a constraint (equation) and proceeds to add either activities or constraints one at a time, solving the subproblems that arise for their optimal solutions. The final solution is attained after adding the last activity or constraint. The algorithm promises to be an efficient one and has several advantages arising from the information supplied about subproblems. 24 pp. Illus. Presented before the Symposium on Linear Programming at Santa Monica, California, March 16-20, 1959.

- P-1491. Prospectus for a reorientation of game theory.** T. C. Schelling. 9-17-58. Unclassified.

An attempt to extend the scope of game theory, using the zero-sum game as a limiting case rather than as a point of departure. The proposed extension consists in identifying the perceptual and suggestive element in the formation of mutually consistent expectations and in identifying some of the basic "moves" that may occur in actual games of strategy and the structural elements on which the moves depend. Game theory is underdeveloped along these lines in that "rational strategies" pursued by two players in a situation of pure conflict should not be expected to reveal what kind of behavior is conducive to mutual accommodation, or how mutual dependence can be exploited for unilateral gain. 125 pp. Illus. Published in *The Journal of Conflict Resolution*, September, 1958. Incorporated in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25.

- P-1492. The progress-curve computer.** D. M. Eisemann. 9-17-58. Unclassified.

A discussion of the progress-curve computer, a device that determines the average cost, unit cost, and total cost for all quantities of output from 1 to 1000. The computer consists of a logarithmic grid on which a family of curves is superimposed. Any specific point on a curve may be assigned any value on the ordinate, and all other points on the curve automatically assume their proper values. An example illustrates how the computer works. Its applications to other uses are considered. 5 pp. Illus. Published in *Operations Research*, January-February, 1959.

- **P-1493. Toward a new weapon-system analysis.** E. B. Berman. 9-23-58. Unclassified.

An attempt to reconstitute weapon-system analysis and cost analysis along lines that include a proper consideration of the uncertainties of weapon-system development as part of the "optimal" decision. The study deals with a structure in which a fixed-generation assumption is central (that is, all of the alternatives apply to the accomplishment of a job for a fixed period of time) and stresses the importance of the cost-probability function. Cases are considered of weapon systems with no reappraisal permitted until the final decision period, together with a case of reappraisal. 17 pp. Illus.

- P-1494. Functional equations and maximum range.** R. E. Bellman. 9-24-58. Unclassified.

An attempt to show how functional equations are used to determine (for various kinds of trajectories) the range, the maximum elevation, and similar quantities as functions of initial position and velocities. Previous studies have treated questions of this type by means of dynamic-programming theory. 7 pp. Published in the *Quarterly of Applied Mathematics*, October, 1959.

P-1495. Invariant imbedding and neutron transport theory—IV: generalized transport theory. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 9-24-58. Unclassified.

An extension of the results of previous papers on the principle of invariant imbedding, as used in the study of a variety of physical processes, to include a large category of transport processes involving deterministic and stochastic interactions and general geometries. Characteristic functions and probabilities, as well as expected value (fluxes), are determined. 14 pp. Illus. Supersedes P-1380 and P-1390. See also P-839, P-976, P-996, P-1102, P-1252, and T-63. Published in the *Journal of Mathematics and Mechanics*, July, 1959.

P-1496. Atmospheric perturbations of artificial satellites. E. A. Leeper. 9-24-58. Unclassified.

A useable reference set of tools for calculating satellite perturbations due to atmospheric drag, or atmospheric densities from measured satellite perturbations. The text contains a derivation of the central equation for perturbation of the semimajor axis. 9 pp.

P-1497-RC. Major implications of a current nonmilitary defense study. Herman Kahn. 1-20-59. Unclassified.

A study suggesting that for the next 10 or 15 years feasible combinations of military and non-military defense measures can preserve society. The measures discussed are intended as insurance against the possible failure of first-priority measures and as a complement to them. It is suggested that \$500 million be spent in the next 2 or 3 years, over and above current budgets, to achieve (1) the creation of modest but worthwhile capabilities by reorienting and strengthening the current civil-defense programs; (2) research and development on all aspects of the state of the art of non-military defense; (3) an effort to develop systems design of various combinations of military and nonmilitary defense; (4) the proper balance between military and nonmilitary expenditures; and (5) inexpensive preparatory actions for use in the 1965 to 1970 time period. 14 pp. Published in the *Bulletin of the Atomic Scientists*, January, 1959.

P-1498. Surface displacements in an elastic half-space. H. A. Lang. 4-1-58. Unclassified.

Results obtained from a study of elastic ground waves initiated by a point load (having a Heaviside time variation) acting on the surface of an elastic half-space. The results consist of (1) integral expressions for displacements and associated potentials everywhere in the half-space for the separate contributions from the P, S, M, and Rayleigh surface wave systems and (2) explicit expressions and curves for the surface displacements for each type of wave; the total surface displacements (evaluated for $\nu = 1/4$) reduce to known expressions obtained by Pekeris. The completeness of the solution and the physical interpretation of results will be discussed in subsequent papers. 42 pp. Illus. See also P-1650, P-1755, P-2054, and P-2215.

P-1499. The space environment. S. H. Dole. 9-15-58. Unclassified.

A discussion of the laws of celestial mechanics and an indication of the space-travel problems posed by meteoritic particles and radiation. 18 pp. Illus. The text of a talk presented before the Long-range Logistics Discussion Group, held at Maxwell Air Force Base, Montgomery, Alabama, September 23, 1958.

P-1500. On control of reactor shut-down involving minimal xenon poisoning. M. Ash, R. E. Bellman, and R. E. Kalaba. 10-3-58. Unclassified.

A treatment of the problem of optimum control of the process of shutting down a high-flux thermal-nuclear reactor to minimize the effects of xenon-135 poisoning. The problem is handled by the functional-equation technique of dynamic programming, relying on the use of high-speed digital computers with large memories. Classical methods of the calculus of variations do not seem applicable to the resulting extremal problem. 15 pp. Also published as RM-2396. See also RM-2189, P-1223, and P-1416. Published in *Nuclear Science and Engineering*, August, 1959.

P-1501. I.G.Y. rockets and satellites: a report on the Moscow meetings, August, 1958. W. W. Kellogg. 9-15-58. Unclassified.

A summarization of some 77 papers presented at the Technical Symposia on Rockets and Satellites during the Fifth Meeting of the Committee Spéciale de l'Année Géophysique Internationale at

Moscow, July 31 to August 9, 1958. Such topics are reviewed as atmospheric structure, electromagnetic properties of the ionosphere, cosmic and auroral particles, solar and stellar ultraviolet and X-ray radiation, micrometeorites, biological experiments, rocket and satellite instrumentation, and rocket and satellite programs. 33 pp. Published in *Planetary Space Science*, Vol. 1, 1959.

P-1502. A machine-job scheduling model. G. B. Dantzig. 4-24-59. Unclassified.

A discussion of a device proposed by Fulkerson and Ford for maximal multi-commodity network flows. A machine-job scheduling model is formulated that avoids the usual in-process inventories and that has fewer equations. The activities are the possible sequence, for each job, of machine steps and interspersed delays which greatly multiply the number of activities. However, a compact network representation of the set of possible activities is developed which permits the generating of just the activity to enter the basis on each iteration without explicitly generating the others. This is accomplished by using one of the efficient procedures that now exist for computing the shortest route through a network. 12 pp. Illus. Published in *Management Science*, January 1960.

P-1503. Operators commuting with translation by one. D. C. McGarvey. 10-1-58. Unclassified.

The use of perturbation techniques to give conditions on the coefficients of nonself-adjoint differential operators of period 1 which ensure that they define spectral (completely reducible) operators in $L_2(-\infty, \infty)$. The spectral theory of these linear operators, which have pure continuous spectrum, is reduced to the uniform treatment of the spectral nature of the differential operator in $L_2(0, 1)$ subject to a class of mixed boundary conditions that yield linear operators with compact resolvents for which perturbations methods developed by J. T. Schwartz and H. P. Kramer apply. The reduction to the $L_2(0, 1)$ case is achieved by establishing a 1-1 isomorphism $A \sim a(\theta)$ between operators A on $L_2(-\infty, \infty)$ which commute with translation by one and $L_2(0, 1)$ operator valued functions $a(\theta)$, $0 \leq \theta < 2\pi$, such that $A = \text{ess sup } a(\theta)$. The isomorphism has the property that if $B \sim b(\theta)$ then $AB \sim a(\theta)b(\theta)$. 225 pp. Illus. See also P-2232.

● **P-1504. Female labor force participation and economic development.** S. E. Haber. 10-1-58. Unclassified.

A study of some aspects of the integration of women into the labor force in the United States. For the periods 1900 to 1930 and 1930 to 1950, the relation is investigated between changes in the sex-age composition of the working-age population and changes in the share of females in the labor force. Several factors influencing the supply of female labor services at a moment of time and over time are considered, together with factors influencing the demand for female labor services. The relation between the growth in industrial distribution of the labor force with the rise in the share of females in the labor force is also considered. 83 pp. Tables.

P-1505. Dilatational surface waves in an elastic half-space. H. A. Lang. 10-2-58. Unclassified.

A derivation of expressions for the surface displacements resulting from the P (dilatational) wave system only, for Lamb's problem when Poisson's ratio $\nu = 1/4$. The partial results agree (when the other wave systems are considered) with the total surface displacements of Pekeris. 9 pp. Illus.

● **P-1506. Performance analysis of plug nozzles for turbojet and rocket exhausts.** W. H. Krase. 9-17-58. Unclassified.

A discussion of the design of convergent-divergent jet nozzles in giving good performance at a given condition, and of their poor off-design performance at important off-design conditions unless a considerable geometric variation is incorporated. The essential feature of the plug nozzles investigated is that with suitable design, an automatic aerodynamic variation of exhaust area can be achieved without mechanical variation. The design and off-design analysis of such nozzles is described, together with applications. 30 pp. Illus. Presented before the American Society of Mechanical Engineers at Cincinnati, Ohio, March 9, 1959.

P-1507. A comment on "Costs, freight rates, and location decisions in the USSR." Hans Heymann, Jr. 10-3-58. Unclassified.

A commentary on a paper presented by Holland Hunter before the Symposium on Economic Calculation and Organization in the USSR and Eastern Europe at Berkeley, California, June 17, 1958. Hunter shows how the structure of Soviet freight charges reflects the government's efforts to influence the economic behavior of producers and to assert the priority of planners' objectives over

producers' preferences. Because this category of producers' prices has been manipulated ineffectively by the Soviet planners to reflect their preferences and demands, Soviet economists are now expressing a growing interest in the role that transportation prices play as market forces. It seems probable, however, that Soviet policymakers will not entrust major decisions controlling economic development to any highly automated mechanical device. 9 pp. Incorporated in *Value and Plan, Economic Calculation and Organization in Eastern Europe*, ed. by Gregory Grossman, University of California Press, Berkeley and Los Angeles, California, 1960. \$7.00.

P-1508. On the concepts of a problem and problem-solving. R. E. Bellman and P. Brock. 1-19-59. Unclassified.

A discussion of the changes in science and technology caused by the use of large-scale computing devices. The power and versatility of these new tools have resolved many problems not only previously unsolved, but also previously unformulated. It is essential that much thought be devoted to the optimal use of current computers and to the future development of computers. The field of mathematics is affected in that a critical analysis of the concept of a solution must be made, as well as of the fundamental concept of a problem. 36 pp. Illus. Published in the *American Mathematical Monthly*, February, 1960.

● **P-1509. Spectrographic observations of the blue haze in the atmosphere of Mars.** A. G. Wilson. 10-6-58. Unclassified.

A discussion of spectrographic observations of the blue haze in the atmosphere of Mars. Whether the earth, like Mars, possesses an extensive haze layer is uncertain. 7 pp. Table. Presented before the International Astronomical Union, Moscow, USSR, August 16, 1958.

P-1510. Simultaneous equations and canonical correlation theory. J. W. Hooper. 10-8-58. Unclassified.

An attempt to contribute toward the understanding of simultaneous-equations estimation as a specific part of the more general theory of multivariate analysis by integrating the econometric analysis of simultaneous equations with certain elements of classical multivariate analysis. In addition, the author seeks to develop a generalized correlation coefficient which measures the extent to which the systematic relationships explain the fluctuations in the set of all jointly dependent variables. 18 pp. Published in *Econometrica*, April, 1959. Presented before the joint meeting of the Econometric Society and the American Statistical Association at Chicago, Illinois, December 29, 1958.

P-1511. Power for satellites. J. H. Huth. 10-8-58. Unclassified.

A discussion of the means for satisfying the inevitably increasing electrical-power requirements of space vehicles. Solar-energy converters appear to be satisfactory up to a few kilowatts, but reactors are the most promising for higher-power levels. 10 pp. Tables. Published as an ASME Publication, Paper No. 59-AV-3 (80¢ per copy, or 40¢ to members of The American Society of Mechanical Engineers). Presented before the American Society of Mechanical Engineers at Los Angeles, California, March 10, 1959.

P-1512. On inequalities with alternating signs. R. E. Bellman. 10-10-58. Unclassified.

A proof that a special case of an interesting inequality due to Steffenson is a generalization of an inequality of Weinberger and Bellman recently found by Olkin. 7 pp. Published in the *Proceedings of the American Mathematical Society*, October, 1959.

P-1513. On the epistemology of the inexact sciences. O. Helmer and N. H. Rescher. 10-13-58. Unclassified.

An outline of a new epistemological approach to the inexact sciences, which include applied physical sciences such as engineering or medicine as well as most of the social sciences. The purpose of all science is to explain past events and to predict future events in an objective manner. In the exact sciences explanation and prediction have the same logical structure. However, in the inexact sciences specifically predictive instrumentalities in these fields and various methodological innovations must be considered. Among these are the systematic use of expert judgment and pseudo-experimentation, involving simulation processes and operational gaming. 71 pp. Published in *Management Science*, October, 1959.

P-1514-RC. The role of political organizations in Indonesia. G. J. Pauker. 10-13-58. Unclassified.

An attempt to show the role of organized groups in contemporary Indonesia and to assess their influence on political developments. Indonesia's independence will not bridge an authoritarian past into a totalitarian future if the organized groups active in public affairs are numerous, alert to their special place in society, and willing to cooperate with other groups. These groups represent social forces operating in a field created by the collective problems to be solved, the habits inherited from the past, and the orientations toward the future. 26 pp. See also RM-2619-RC, RM-2637-RC, and P-1452-RC. Published in *Far Eastern Survey*, September 1958. Presented before the American Political Science Association at St. Louis, Missouri, September 4-6, 1958.

P-1515. On the foundations of dynamic programming. H. A. Osborn. 10-14-58. Unclassified.

A proof that Bellman's formalism in the calculus of variations furnishes an approximation which converges to the value of the slope function at any given point of the field of extremals. 12 pp. Published in the *Journal of Mathematics and Mechanics*, November, 1959.

P-1516. Single ownership of a superior resource: the road case again re-examined. W. H. Meckling. 10-15-58. Unclassified.

A discussion of the question of (1) the implications of various institutional arrangements for efficiency of road use and (2) whether centralized ownership of a commonly used resource, e.g., the superior road, will result in efficient use. It is determined that centralized ownership will result in efficient use of the superior road, even if the individual firm's demand-curve for the superior road is negatively inclined. This conclusion should not be assumed for the general case of common usage without recognizing the special nature of this particular road problem. 18 pp. Illus.

• **P-1517. The peacetime use of military airlift.** J. R. Summerfield. 10-14-58. Unclassified.

An attempt to determine the appropriate way to use military airlift in peacetime. This question is significant in that (1) the cost of providing wartime peak airlift capacity in the system is determined by how much money needs to be spent on the system in peacetime; and (2) the way the system is used in peacetime may strongly influence the speed with which it responds to a sudden wartime demand. Alternative peacetime concepts for the operation of the system are considered, together with economical modes of peacetime operation with the necessary wartime capability. 9 pp. Presented before the Operations Research Society of America at St. Louis, Missouri, October 23, 1958.

P-1518. Problems of range measurement with special application to the establishment of an orbit of an artificial asteroid. C. M. Crain. 10-14-58. Unclassified.

A discussion of problems of range measurement as they affect the establishment of the orbit of an artificial asteroid. 2 pp. Presented before the Inter-Range Instrumentation Group Symposium at Monterey, California, October 10, 1958. Also presented before the Seventh Regional Conference of the Institute of Radio Engineers at Albuquerque, New Mexico, May 13, 1959.

• **P-1519. A consideration of fuels for future air transportation systems.** T. F. Kirkwood. 10-8-58. Unclassified.

An examination of numerous possible fuels for use in future air transportation systems. The fuels or energy sources discussed are (1) petroleum obtained from oil shale and coal conversion, (2) hydrocarbons obtained by photosynthesis involving the fermentation of algae, (3) liquid hydrogen, and (4) nuclear energy. 14 pp. Illus. Presented before the Institute of the Aeronautical Sciences at Los Angeles, California, November 11, 1958.

• **P-1520. On the drag of a sphere moving in a partially ionized atmosphere.** H. H. Chang and M. C. Smith. 6-13-58. Unclassified.

A consideration of the Coulomb attraction or repulsion of charged particles as they affect the atmospheric drag forces acting on a satellite at altitudes of 500 km or greater. For altitudes of 800 km the free particle model is appropriate in calculating the increase in drag due to ions that stick to the surface of the satellite and those that pass near the satellite. At the lower altitude of 250 km, the much greater density of neutral particles overshadows completely the effects of Coulomb interactions.

For intermediate altitudes between 250 and 800 km, the theory may be useful in giving approximate magnitudes of the Coulomb interactions. 17 pp. Illus. Published in the *Journal of the British Interplanetary Society*, January–February 1960.

P-1521. Reliability estimating by the use of random sampling simulation. S. I. Firstman. 10-20-58. Unclassified.

The application of random sampling simulation to the problem of predicting system performance based upon component and "black-box" performance data. The validity of results and the unbiased nature of derived estimates are argued heuristically, and the requirements for input data are explained by the use of hypothetical examples. 29 pp. Illus. Presented before the 5th Joint Military-Industry Symposium on Guided Missile Reliability at Chicago, Illinois, December 8–10, 1958, and published in the proceedings of the Symposium.

● **P-1522. The economic development of Morocco.** L. G. Cowan. 10-21-58. Unclassified.

A discourse on the economic development of Morocco which covers the history of the country from its earliest days to the present, the organization of the French Protectorate in 1912, Morocco's resources and industry, investment in Morocco and foreign trade, the impact of independence on Moroccan labor, the role of government in Moroccan economic development, and the future development of Morocco. The author concludes that if Morocco continues to make strides toward responding to the demands of industrialization, its future economic development will rest on a solid foundation. 139 pp. Illus.

P-1523. Correlation energy of a degenerate electron gas. R. A. Ferrell. 9-5-58. Unclassified.

A proof (1) that the equation for the potential correlation energy of a degenerate electron gas in terms of the total energy provided by the virial theorem is identical to that obtained by differentiating the ground-state-energy eigenvalue in connection with the electrostatic coupling constant; (2) that the second derivative of the correlation energy in connection with the coupling constant can never be negative; (3) that the asymptotic behavior of the zero-point energy is not properly represented by Wigner's interpolation formula; and (4) that all correlation calculations can, with minor modifications, be applied to the ferromagnetic state of the electron gas. 23 pp. Illus. Also published as RM-2271.

● **P-1524. Direct-power conversion—part I: general comments.** J. H. Huth. 10-21-58. Unclassified.

A study of direct-power conversion (conversion of any other form of energy to electricity in one step) in relation to space-vehicle energy requirements. The merits of direct conversion in terms of weight savings and increased reliability are discussed, and such direct-conversion devices as solar cells, fuel cells, and thermocouples are reviewed. 12 pp. Illus. Presented before the Advanced Propulsion Systems Symposium at Los Angeles, California, December 11–13, 1957.

P-1525. Calculus of variations and its applications: a book review. R. E. Kalaba. 10-23-58. Unclassified.

A review of a recently published book consisting of papers presented at the Eighth Symposium in Applied Mathematics, held in April, 1956. Topics include the calculus of variations and its applications to elasticity, plasticity, electromagnetic theory, mathematical economics, and other fields. 4 pp.

P-1526. Sequencing n jobs on two machines with arbitrary time lags: alternate proof and discussion of general case. S. M. Johnson. 10-27-58. Unclassified.

An alternate proof of a result of L. G. Mitten in solving the problem of sequencing n jobs through two machines with arbitrary time lags, assuming similarity of the job sequences for both machines. The more difficult general problem is discussed and partially solved. 10 pp. Published in *Management Science*, April, 1959.

● **P-1527. Dynamic-programming algorithms and formulations.** S. E. Dreyfus. 10-28-58. Unclassified.

A discussion of four algorithms for the solution of dynamic-programming processes. The areas of applicability of each are indicated, and the solution of a particular problem by the use of each algorithm is considered. 15 pp. Illus.

P-1528. Statistical methods in radio-wave propagation. W. C. Hoffman. 10-28-58. Unclassified.

The text of an address presented to the International Scientific Radio Union at University Park, Pennsylvania, October 21, 1958, and published in the proceedings of the meeting. Current knowledge of the application of statistical methods to radio-wave propagation is reviewed. Contributions of individual workers are mentioned. Outstanding problems in the field are also indicated. 15 pp.

P-1529. Functional equations, wave propagation, and invariant imbedding. R. E. Bellman and R. E. Kalaba. 10-28-58. Unclassified.

A proof that wave propagation in inhomogeneous media may be studied through the use of invariance principles similar to those used in radiative transfer and neutron transport theory. A wave-localization principle is proved. The analytical techniques derived furnish a new approach to some significant problems in mathematical physics, while the physical concepts provide new insight into the analytic structure of the solutions of the one-dimensional wave equation. 44 pp. Illus. Published in the *Journal of Mathematics and Mechanics*, September, 1959.

• **P-1530. Systems analysis versus systems design.** A. J. Wohlstetter. 10-29-58. Unclassified.

An examination of the design and formulation of an economic systems analysis of defense problems. The paper includes a discussion of systems analysis versus models, an Air Force example (the genesis of the intercontinental mission), the objectives and constraints in the design of systems studies, the enemy's objections and agreements, the modest value of mutually unsatisfactory strategies, uncertainty and the design of systems studies, and systems design versus systems analysis. 64 pp. Illus.

P-1531. Some complexities in military planning. M. W. Hoag. 12-11-58. Unclassified.

An application of economic theory to show some prevailing oversimplifications in military discussion. Requirements and priority approaches to military allocations are criticized, and the complications introduced by increasing and interdependent returns are illustrated. Some implications for defense doctrine and organization are presented. 36 pp. Published in *World Politics*, July, 1959.

P-1532. The dual of a transportation problem is not a transportation problem. G. B. Dantzig. 10-30-58. Unclassified.

A proof that the dual of the classical transportation problem—after elimination of the variables unrestricted in sign—cannot by row operations be reduced to transportation format, nor can it be so reduced by augmenting the system with k additional variables and equations. The dual of the transportation problem possesses the unimodular property that every subdeterminant has value 0, 1, or -1 . Therefore, extreme point solutions have integer values if the constant terms are integer valued. The question is undetermined whether unimodular systems exist which are more general than those derived from transportation (distribution) problems. 7 pp.

P-1533. A multimove allocation game. L. D. Berkovitz and M. Dresher. 10-30-58. Unclassified.

An analysis, as a multimove two-person game, of the problem of allocating two types of resources (bombers and fighters) among three independent tasks (attack, defend, and score). Optimal tactics are derived: (1) during the last moves of the game both players allocate all their resources, regardless of the size of their resources; and (2) during the early moves of the game, both players may need to randomize, or only one player may need to randomize, depending on the size of their resources. 32 pp. Illus. See also RM-2399 and P-1914.

P-1535. On lunar and planetary experiments. S. M. Greenfield. 10-29-58. Unclassified.

A report to the Lunar and Planetary Exploration Colloquium by the Subcommittee for Lunar and Planetary Experimentation. Numerous possibilities for lunar and planetary experiments are outlined, and the suggested experiments are organized into three main categories. The paper is concerned mainly with the issue of contamination (biological, chemical, and radioactive). The experiment categories are organized so that the experiments that do not involve contamination are given priority. 9 pp. Tables. Presented before the Lunar and Planetary Exploration Colloquium at Pasadena, California, October 29, 1958, and published in the proceedings of the Conference.

- **P-1536. Low-thrust transfer between circular orbits.** Eugene Levin. 10-31-58. Unclassified.

A study to determine transfer trajectories between circular satellite orbits when using low-thrust, high-specific-impulse propulsion systems. Reasonably simple steering programs and associated execution times are presented for the fundamental operation of coplanar transfer and change of orbit plane. 32 pp. Illus. Condensation published in *Mechanical Engineering*, April 1959. Presented before the American Society of Mechanical Engineers at Los Angeles, California, March 10, 1959.

- **P-1537. Growth models and the escape from the low-level equilibrium trap: the case of Japan.** R. R. Nelson. 1-6-69. Unclassified.

A restatement of the equilibrium growth model and the special case of the low-level equilibrium trap. The growth of the Japanese economy from 1868 is shown as an escape from the low-level equilibrium trap and as a takeoff into sustained growth. Although Schumpeterian innovation is probably the primary factor explaining the increase in output from given factor endowments in advanced economies, improved and fuller allocation may be more important in backward economies. 23 pp. Illus. Published in *Economic Development and Cultural Change*, July 1960.

- P-1538. Determinantal methods in latent class analysis.** Albert Madansky. 11-4-58. Unclassified.

Some extensions of the existing determinantal methods for solving the accounting equations in latent class analysis. These extensions cover more cases than previous methods, produce new sufficient conditions for identifiability of the latent class model, and show the necessity of various sufficient conditions for identifiability. Implications to the identifiability problem are discussed. 31 pp. Published in *Psychometrika*, June 1960.

- P-1539. Supersonic transports.** T. F. Cartaino, R. B. Johnston, and T. F. Kirkwood. 11-3-58. Unclassified.

A review of past predictions concerning supersonic transports. The technical state of the art of these early transport aircraft is compared with that of aircraft which could be operational about 1970. These advanced aircraft are evaluated within the context of typical airlift missions. The economics and operating characteristics of advanced supersonic transports are discussed, together with the implications of extra-economic factors. One of the associated technical problems, that of possible alternative fuels, is given special attention. 37 pp. Illus. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, November 11, 1958.

- P-1541. Lines of force of the geomagnetic field in space.** E. H. Vestine and W. L. Sibley. 11-7-58. Unclassified.

A tracing of the lines of force of the geomagnetic field from points in the northern hemisphere to their intersections with the earth's surface in the southern hemisphere. The authors conclude that the geomagnetic field has stability and a simple character even at distances as great as about 6 earth radii above the earth, measured in the equatorial plane, even during auroral displays. 14 pp. Illus. Published in *Planetary and Space Science*, September 1959. Presented before the American Geophysical Union at Washington, D.C., May 4, 1959.

- **P-1542. Suitability of solid and liquid rocket engines for placing manned satellites on orbit.** Martin Goldsmith. 11-10-58. Unclassified.

A paper dealing with the many comparisons of differing rocket engine systems for various missions that restrict themselves to performance considerations only (as represented by minimum gross weight). Experience has shown that operational considerations are often more important in determining true over-all mission cost and suitability. The problem of placing large manned satellites on orbit using chemical rockets is examined, with particular attention given to those factors influencing over-all cost or feasibility. 12 pp. Presented before the American Society of Mechanical Engineers at Los Angeles, California, March 10, 1959.

- P-1544. A decomposition principle for linear programs.** G. B. Dantzig and P. S. Wolfe. 12-10-59. Unclassified.

A procedure for the efficient computational solution of linear programs having a certain structural property characteristic of a large class of problems of practical interest. The property makes possible

the decomposition of the problem into a sequence of small linear programs whose iterated solutions solve the given problem through a generalization of the simplex method for linear programming. 25 pp. Illus. See revision RM-2813-PR. See also P-1664. Published in *Operations Research*, January–February 1960, and also in *Econometrica*, October 1961. Presented before the American Mathematical Society at Philadelphia, Pennsylvania, January 20, 1959.

P-1545. Computing tetraethyl lead requirements in the linear programming format.

G. B. Dantzig, T. K. Kawarantani, and R. J. Ullman. 6-26-59. Unclassified.

A discussion of some types of non-linearities that are difficult to incorporate into a linear programming model. One of these occurs in the scheduling of refinery operations where linear programming methods are widely used. The specific problem is one of determining simultaneously the quantities of various components of gasoline and tetraethyl lead to blend to form regular or premium type gasolines. It is believed that the general approach can be used for other non-linear situations. Linearization is accomplished by viewing the lead requirements of a blend first as a known general function of two variables, each of which is a linear function of the quantities in the blend. The general function is approximated by a convex linear combination of a mesh of representative points. 13 pp. Illus. Also published as RM-2425. Published in *Operations Research*, January–February 1960. Presented before the Operations Research Society of America at Philadelphia, Pennsylvania, May 9–10, 1957.

P-1548. A simulation model of Air Force maintenance operations. R. A. Levine and R. B. Rainey. 11-13-58. Unclassified.

A description of a model which simulates aircraft maintenance and operations at the air base level. The model is of the random sampling or Monte Carlo type programmed for the IBM 704 computer. Using the model to make predictions, it is possible to eliminate certain field testing and to select key estimates of mission regimes and maintenance organizations to be subjected to confirmation through actual field testing. The model is highly useful for making planning recommendations in situations new to the Air Force and has proved advantageous in RAND's maintenance research efforts. 10 pp. See also RM-2374 and P-1552. Presented before the Operations Research Society of America at St. Louis, Missouri, October 24, 1958.

P-1549. "The cultural and social impact of an American airbase upon an urban French community. By Orvoell R. Gallagher": a summary. W. P. Davison. 10-13-58. Unclassified.

Observations on relations existing between French and American personnel in a French city where a major U.S. airbase is located. Various measures to help improve these relations are suggested: (1) surveys should be made of social and economic conditions in communities near overseas airbases; (2) better liaison channels between the bases and community leaders should be established; (3) formal rather than informal social contacts should be stressed where appropriate; (4) steps should be taken to inform community leaders of the advantages of living near an airbase; and (5) additional emphasis should be placed on language study for key personnel. 30 pp.

● **P-1550-RC. Some mathematical aspects of chemotherapy—I: one-organ models.** R. E. Bellman, J. Jacquez, and R. E. Kalaba. 6-9-59. Unclassified.

The first of a series of papers discussing the qualitative and quantitative aspects of chemotherapy, the treatment of disease through the use of chemical reagents that kill specific types of cells while leaving the patient relatively unpoisoned. Specifically, the series deals with the distribution of a compound in the organs of the body after its injection into the blood stream. The present study considers several simplified mathematical models in which the heart pumps blood to just one organ. It is hoped ultimately to find the characteristics of the most efficacious drugs to use and the manner of their injection. 27 pp. Illus. See also P-1560. Published in *The Bulletin of Mathematical Biophysics*, June 1960.

P-1551. On an application of dynamic programming to the synthesis of logical systems. R. E. Bellman, J. Holland, and R. E. Kalaba. 11-18-58. Unclassified.

An application of dynamic programming to problems arising in the synthesis of logical systems. In a number of fields a system in one state must be optimally converted into another state (e.g., in

mathematical economics, in the theory of control processes, in network theory, and in trajectory processes). The present study considers a type of question occurring in the design of computers and switching circuits. The problem is treated in general terms, and a special example is given to illustrate the methods. 16 pp Illus. Published in the *Journal of the Association for Computing Machinery*, October, 1959.

- **P-1552. Random variations and sampling models in production economics.** R. A. Levine and R. B. Rainey. 11-19-58. Unclassified.

An attempt (1) to describe a particular production function in which random phenomena play a major part in the aircraft maintenance process, (2) to examine a simulation model used to predict the outputs of the process, and (3) to discuss the importance of random factors to the economics of production and the use of simulation models in economics. Random phenomena in production economics are found to be more important than has been realized, and the possibility of the random sampling method as a useful technique for studying them is considered. 22 pp. Illus. See also RM-2374 and P-1548. Presented before the Econometric Society at Chicago, Illinois, December 27-29, 1958.

- **P-1553. Cosmic terrestrial relations.** H. K. Kallmann. 11-20-58. Unclassified.

An article written for the McGraw-Hill *Encyclopedia of Science and Technology*. This paper on cosmic terrestrial relations includes such topics as (1) the earth and the planets in relation to the universe; (2) the age of the earth; (3) the origin and development of the earth; and (4) wave and corpuscular radiation from the sun, the stars, and the galaxies. 6 pp.

- **P-1555. The simulation of a large-scale military activity.** M. A. Geisler. 3-12-59. Unclassified.

A description of the first experiment of the RAND Logistics Systems Laboratory, which tested a series of logistics policies in a detailed man-machine simulation. The paper discusses the policies, the elements simulated, the operation of the experiment, and its results. The second, or current, experiment of the Laboratory is mentioned. 26 pp. Illus. Published in *Management Science*, July 1959. Presented before The Institute of Management Sciences at Philadelphia, Pennsylvania, October 17, 1958.

- **P-1556. Comments on automobile traffic.** J. D. Williams. 11-24-58. Unclassified.

An attempt to view automobile fatalities in context. The thesis discussed is that a substantial number of fatalities is an inevitable consequence of an operation of the magnitude and character of that conducted on our highways, that the present rate is not alarming when viewed against the value derived from the automobile, and that the rate can probably be reduced; but it is important to use only such measures as do not simultaneously reduce the utility of the operation. 21 pp. Published in *Fortune*, September, 1958, and in *Sports Cars Illustrated*, June, 1959.

- **P-1557. The symposium on the use of space vehicles at the fall, 1958, URSI meeting.** W. C. Hoffman. 11-25-58. Unclassified.

An account of a recent panel discussion of five classes of proposed experiments involving radio instrumentation of space vehicles. The types of experiments discussed concern VLF satellite measurements, ion probes, Faraday rotation measurements, topside ionospheric sounders, and anomalous propagation. 25 pp. Illus.

- **P-1558. A layman's review of propulsion and propellants for space flight.** Martin Goldsmith. 12-1-58. Unclassified.

An examination of the principles of operation of propulsion systems. The types and performance criteria of both propulsion systems and propellants are also considered. 21 pp. Illus.

- **P-1559. The status and improvement of physical constants needed for precision trajectories.** Samuel Herrick. 12-1-58. Unclassified.

A discussion of the need for the refinement of various physical constants underlying precision trajectory work, with particular emphasis on the gravitational constants and solar parallax. Careful attention must be paid to rocket-launched vehicles, especially in earth-moon traffic. Interplanetary trajectories are the most critical, however, involving uncertainties up to 600 000 miles for planetary targets a few thousand miles in diameter. 10 pp.

P-1560-RC. The distribution of a drug in the body. J. A. Jacquez, R. E. Bellman, and R. E. Kalaba. 12-1-58. Unclassified.

A continuation of P-1550, *Some Mathematical Aspects of Chemotherapy—I: One-organ Models*, which considers a model of the distribution of a compound within the plasma flowing through a capillary bed and within the extracellular space and intracellular space. The model includes the possibility of the reaction of the drug with a component of the intracellular space. The present paper extends the model to include the effects of the major tissues of the body and circulation. An attempt is made to show the relationship of this general problem to feedback problems, input-output analysis, and transportation problems arising in economic and engineering control processes. 22 pp. Illus. Published in *The Bulletin of Mathematical Biophysics*, September 1960.

- **P-1561. Satellite perturbations resulting from lunar and solar gravitational effects.** Eugene Levin. 12-1-58. Unclassified.

A study to determine, by means of elementary mathematical techniques, the first-order perturbations of a circular satellite orbit about the earth due to the gravitational field of the sun and moon. The principal secular and periodic effects are obtained, and the magnitudes of these effects are computed for a typical earth satellite. 30 pp. Illus.

- P-1562. Soviet periodical literature on astronautics.** F. J. Krieger. 12-1-58. Unclassified.

A discourse on the many problems confronting Western readers interested in Soviet developments in astronautics. The Soviet press not only frequently misinforms its readers, but also never presents facts objectively. The Soviets prefer to publish their astronautical studies in their own rigidly controlled media. Tables presented list Soviet newspapers, journals published by the USSR Academy of Sciences and by various institutes and ministries, and Soviet abstract and reference journals that carry articles on or pertaining to astronautics. 12 pp. Illus. Published in *Astronautics*, April 1959.

- P-1563. A mathematical model for multiplication by binary fission.** T. E. Harris. 1-6-59. Unclassified.

An explanation of the use of the "point of regeneration" in the mathematical treatment of the multiplication of biological cells by binary fission. 35 pp. Presented before the Conference on Cellular Proliferation at Salt Lake City, Utah, January 21, 1959, and published in the proceedings of the Conference.

- P-1564. Upper-atmosphere properties based on rocket and satellite data.** H. K. Kallmann. 12-8-58. Unclassified.

An account of the more important recent advances in high-altitude research based on rocket and satellite data. A quantitative picture of our current knowledge of atmospheric physics is given, and some findings are included that have not yet been properly integrated into our new picture of the atmosphere. 20 pp. Illus. Incorporated in *Physics and Medicine of the Atmosphere and Space*, ed. by O. O. Benson and H. Strughold, John Wiley & Sons, Inc., New York, 1960. \$12.50.

- P-1565. On the role of clear sky turbidity in atmospheric infrared transmission.** Diran Deirmendjian. 12-3-58. Unclassified.

A discussion of the effect of natural haze (aerosol particles) on the transmission of infrared in the water vapor windows. The continuous absorption spectrum of liquid water is examined. It is shown that the absorption coefficient is unimportant as far as the scattering cross section of water droplets is concerned for infrared of wavelengths less than 2.5μ . The extinction spectra, computed on the basis of a water haze having a continuous drop size distribution, agree rather well with atmospheric measurements both in the horizontal and the vertical directions. 39 pp. Illus. Published in the *Quarterly Journal of the Royal Meteorological Society*, October 1959.

- **P-1566. The place of limited war in NATO strategy.** M. W. Hoag. 12-4-58. Unclassified.

A general consideration of the way in which limited war fits into NATO strategy. The official view that a limited-war capability is a by-product of other capabilities is criticized because the main products are questionable. Alternatives to a limited-war strategy, and the issue of nuclear versus primarily non-nuclear limited-war preparedness, are appraised. 48 pp. Incorporated in *NATO and*

American Security, published by Princeton University Press, Princeton, New Jersey, 1959. \$6.00. Presented before the Conference on NATO Strategy at Princeton University, Princeton, New Jersey, January 13-16, 1959.

- **P-1567. Money and the interest rate in a neoclassical world.** A. C. Enthoven. 12-4-58. Unclassified.

A presentation of the argument that the action of the monetary system, from the viewpoint of its impact on the rest of the economy, changes the relative supplies of the various financial assets in the hands of the private sector. In turn, this affects the rate of interest and other variables. An attempt is made to show that if the rate of consumption of the household sector is influenced by its financial asset holdings, and if the investment decisions of firms are affected by the extent to which they are in debt, then the actions of the monetary system can be neutral only in very special cases. In general, price and wage flexibility, the absence of money illusion, and the absence of interest-bearing government debt do not imply that monetary policy is neutral. 21 pp. Presented before the Econometric Society at Chicago, Illinois, December 20, 1958.

- **P-1568. A discussion of space vehicle guidance problems.** F. T. Smith. 12-4-58. Unclassified.

A consideration of initial midcourse, terminal-guidance, and orbit-transfer problems for space vehicles. Inertial, radar, and other guidance systems are compared, and future guidance requirements are indicated. 34 pp. Illus. Incorporated in *Space Handbook, Astronautics and Its Applications*, published by Random House, Inc., New York, 1959. \$3.95.

- P-1569. The Soviet industrial reorganization of 1957.** Oleg Hoeffding. 12-12-58. Unclassified.

A discussion of several aspects of the reorganization of industrial administration and planning carried out in the Soviet Union in 1957. The author considers the 1957 reform both a radical and conservative measure. It is radical in that centrally determined plans and policies are implemented by regional executive agencies, placed in general charge of their region's industry, regardless of branch affiliation. It is conservative in that it tries to correct various faults in the operation of industry, and in its structural and locational patterns, not by amending any of the basic institutions and operating principles of the Soviet economic system, as it applies to industry, but by organizational and procedural improvements within it. 23 pp. Published in *The American Economic Review*, May, 1959. Presented before the American Economic Association at Chicago, Illinois, December 27, 1958.

- **P-1570. Impressions of Russia in 1958: a trip report.** R. C. Tucker. 11-30-58. Unclassified.

Observations of a trip, taken in 1958 with the staff of former Governor Adlai Stevenson, to the Soviet Union. The author, who is well acquainted with the Soviet Union as a result of eight years' service with the U.S. Embassy at Moscow, served as aide and interpreter to Mr. Stevenson during his travels in Russia and Poland. Various phases of the trip in Leningrad and Moscow, Central Asia, Siberia, the Urals, and the Volga are described, together with conversations held in Moscow. An account of an interview with Khrushchev is included. 201 pp.

- **P-1571. Some political and economic aspects of overseas missile bases.** M. W. Hoag. 12-8-58. Unclassified.

A brief consideration of some questions that the State Department should put to military planners about intermediate-range ballistic missile installations in allied countries. Possible provocation of the Soviet Union, repercussions upon our allies, ground vulnerability and the time required for joint firing decisions, and the impact upon the division of military labor within alliance are discussed as problems associated with IRBM's. 10 pp. Incorporated in *Agenda for American Action*, published by the University of Southern California Press, Los Angeles, California, 1959. \$5.00.

- P-1572. Quantitative and qualitative approaches to content analysis.** A. L. George. 12-9-58. Unclassified.

A discourse on the respective merits and uses of "quantitative" and "qualitative" approaches to content analysis. After the two terms are defined, frequency and non-frequency content indicators are discussed to help differentiate between quantitative or statistical content analysis and the non-quantitative approach to the analysis of communication. Some examples and characteristics of non-frequency content analysis are given, together with the difficulties in applying quantitative content

analysis for the study of instrumental aspects of communication. 47 pp. Incorporated in *Propaganda Analysis*, Row, Peterson & Co., Evanston, Ill., 1959. \$6.00. Published in *Trends in Content Analysis*, ed. by Ithiel de Sola Pool, University of Illinois Press, Urbana, Ill., 1959. \$7.50.

P-1573. Functional equations in adaptive processes and random transmission. R. E. Bellman and R. E. Kalaba. 2-2-59. Unclassified.

A discussion of recent applications of the functional-equation techniques of dynamic programming and invariant imbedding to the study of (1) some problems arising in the theory of adaptive control processes and (2) transmission through random media. Also considered are other applications that have been made in modulation theory, communication theory, and network analysis. 12 pp. Illus. Published in the *Transactions of the 1959 International Symposium on Circuit and Information Theory*, held at the University of California, at Los Angeles, June 16-18, 1959.

● **P-1574. Surprise attack and disarmament.** T. C. Schelling. 12-10-58. Unclassified.

An examination of the relation of surprise-attack schemes to the general idea of "disarmament" and to the stability of a situation of mutual deterrence. In some contexts stability may be achieved with more weapons, not fewer, and there may be circumstances in which it may be reassuring to know that the enemy feels secure. Therefore, the philosophy of surprise attack schemes is not only at variance with the traditional notion of "disarmament," but also with the traditional notion of arms superiority. The problem of safeguards against war by misunderstanding is discussed, and the question of whether successful surprise attack schemes will leave us incapable of deterring anything but a massive attack on ourselves is considered. 50 pp. Incorporated as Chapter XI in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Mass., 1960. \$6.25. Presented before the Conference on NATO Strategy for the Security of the West at Princeton University, Princeton, New Jersey, January 15, 1959.

P-1575. Some military aspects of supersonic transports. T. F. Cartaino, R. B. Johnston, and T. F. Kirkwood. 12-31-58. Unclassified.

A discussion of military air transport and of the circumstances in which it may be desirable to procure supersonic transports. The study attempts to show that a decision to spend military research and development funds on a supersonic transport is one based on an evaluation of the relative importance of conflicting extra-economic factors and that a development decision need not be made for several years unless national prestige is of overriding importance. 33 pp. Illus. Presented before the Institute of Aeronautical Sciences at New York City on January 26-29, 1959, and published in the proceedings of this Conference on Supersonic Transports (Sherman M. Fairchild Publication Fund No. FF-20).

● **P-1576-RC. Burma's foreign policy and the Korean War: a case study.** Isobel Crocker. 12-12-58. Unclassified.

A discussion of Burmese foreign policy from 1947 to 1954 in connection with the Korean War, United Nations action, and related issues. Burma's initial response to the U.N. action against the North Korean attack was instantaneous and favorable. Burma participated in international debate on terms of equality with the big powers. The action of the Burmese delegation in the U.N. on Korean questions reflected their growing awareness of the power of the Moscow-Peking axis. The fact that the U.N. was no better a collective security system than the more powerful nations were willing to make it has hindered small nations in preserving their independence and security. 75 pp.

P-1577. Environmental requirements for extended occupancy of manned satellites. S. H. Dole. 12-12-58. Unclassified.

A review of the physical environmental conditions needed to keep a man functioning efficiently in an earth satellite. The main environmental conditions considered are composition and pressure of the atmosphere, gravitational forces, temperature, and radiation. Illustrative examples of the associated payload weights required per man as a function of mission duration are given. 28 pp. Illus. Published as an ASME Publication (Paper No. 59-AV-12). Presented before the Aviation Conference of the American Society of Mechanical Engineers at Los Angeles, California, March 11, 1959.

P-1578. An economic development of strategic significance in Communist China. R. H. Moorsteen. 12-15-58. Unclassified.

A discussion of the military implications of the Chinese Communist program, initiated toward the end of 1957, of building very small industrial enterprises to be located in towns, rural villages, or

on collective farms. While it is still too early to evaluate the small plant campaign, it will result in an unusual decentralization of future economic development and in the Chinese economy's becoming extraordinarily resilient under enemy attack, if it fulfills even a part of Chinese expectations. Furthermore, the new patterns of development, relying primarily on relatively unskilled labor, local building materials, and widely distributed natural resources, are well adapted to the work of economic recuperation in a post-attack period. 5 pp.

P-1579-RC. Some attributes of the changing society. J. D. Williams. 12-15-58. Unclassified.

Part of a broader investigation concerned with the place of mathematics in the changing society, prepared in response to an invitation from the National Council of Teachers of Mathematics. The paper surveys and discusses implications of certain striking features of our times, external and internal to our society, such as the rate of change of technology and population growth. The fact is emphasized that we have a lot of thinking to do and not much time to do it in and that it would be wise to make decisions and choices deliberately while there are real alternatives, rather than by default when there are none. 23 pp. See revised version P-1772-RC.

P-1580. The research frontier. R. E. Bellman. 12-16-58. Unclassified.

A description of some of the interesting and as yet unsolved mathematical problems that have arisen in the study of adaptive control processes. 6 pp. Published in *Saturday Review*, January 5, 1959.

P-1581. Simulation and stimulation. R. E. Bellman. 12-17-58. Unclassified.

An analysis of the qualities required for the successful construction of mathematical models of economic, psychological, and military processes. Why the universities have almost completely failed in the job of turning out people possessing these qualities is also discussed. 14 pp. Presented before the Second National Symposium on Simulation Processes at Chicago, Illinois, February 3, 1959, and published in the proceedings of the Symposium.

P-1582. The economic analysis of defense: choice without markets. F. S. Hoffman. 12-19-58. Unclassified.

The application of some of the more general concepts and propositions of economic theory to military decisionmaking, with particular attention given to the allocation of scarce resources for research among competing uses. Research on defense problems must be carefully defined by the construction of a preference ordering, a knowledge-getting process to discover more about alternatives. In turn, this knowledge suggests new objectives and instrumentalities to make a preference ordering possible in the face of inherent uncertainties. Objectives of this research must be appropriately modest by measuring our desire for ever better decisions against the limited resources available to improve these decisions. 18 pp. Published in *The American Economic Review*, May, 1959. Presented before the American Economic Association at Chicago, Illinois, December 27, 1958, and published in the proceedings of the Association.

P-1583. Gains from trade, materials supplies, and economic development. Charles Wolf, Jr. 1-2-59. Unclassified.

An assessment of the feasibility of the objectives of U.S. economic assistance to underdeveloped countries from the standpoint of their connection with economic development, defined in terms of secularly rising national income. The connection between economic development on the one hand, and, successively, U.S. terms of trade, volume of trade, and materials supplies on the other, is shown to be too uncertain for these to be practical objectives of development aid. Aid directed toward maximizing development will not necessarily maximize trade gains and materials supplies. Maximum development may even reduce U.S. gains from trade with, and U.S. materials supplies from, the underdeveloped countries. 20 pp. Illus. Incorporated in *Foreign Aid, Theory and Practice in Southern Asia*, Princeton University Press, Princeton, New Jersey, 1960. \$7.50.

P-1584. Report on a general problem-solving program. A. Newell, J. C. Shaw, and H. A. Simon. 2-9-59. Unclassified.

A description of a computer program, called GPS-I (General Problem Solving Program I). GPS-I attempts to construct computer programs that can solve problems requiring intelligence and adaptation

and to discover which varieties of these programs can be matched to data on human problem solving. The present paper does not relate the program to human behavior, but describes its main characteristics and assesses its capacities as a problem-solving mechanism. In addition, this study considers the kinds of problems on which GPS-I can work, the performance it shows with these problems, problem-solving techniques not incorporated in GPS-I, and the limits of the program for growth and learning. 29 pp. Illus. See also P-1742, P-2257, and P-2349. Presented before the UNESCO International Conference on Information Processing, at Paris, France, June 19, 1959, and published in the proceedings of the Conference.

P-1585. Masers and irasers. R. W. Gelin. 12-30-58. Unclassified.

A discussion of the fundamental limits of sensitivity for infrared maser detectors. It is concluded that for the usual infrared detection problems the IR maser detectors offer no advantages over conventional detectors. Only in the rather artificial circumstance where the target is a highly monochromatic infrared source is an ideal IR maser superior to present detectors. 25 pp. Illus. Presented before the Sub-Group on Statistics and Detection of the Infrared Information Symposium at Santa Monica, California, January 7, 1959, and published in the proceedings of the Symposium.

P-1586. Random simulation of an air base inventory control system for a reparable part. H. S. Campbell. 1-7-59. Unclassified.

A description of a random sampling simulation (or Monte Carlo) model of an inventory control system for a single commodity. The system represented is the spare parts supply function of an Air Force base. This model may serve as a computational aid for simulating the response of a complex inventory system under varying conditions of uncertainty. The variables considered are the base resupply time for both routine and priority requisitions, the degree of reliance placed on base maintenance, and the relationship between supply decision rules, or stockage policies, and the demand prediction technique used. 25 pp.

P-1587. Centralization and decentralization in economic organizations. T. A. Marchak. 1-7-59. Unclassified.

An attempt to clarify the issues involved in choice among schemes for sharing the task of decision-making in a firm or, more generally, in an organization that is an abstraction from the profit-maximizing firm and is faced with regular repetitions of this task in the face of a changing environment. The study is concerned with schemes that are analogs of the decentralized "solution" of socialist economics, of the centralized solution, or of solutions that are neither centralized nor decentralized. A model of the organization and of the schemes used is discussed to help determine which class of system is preferable. 52 pp. Tables. Published in *Econometrica*, July 1959.

P-1588. The use of machines in the construction of a grammar and computer program for structural analysis. K. E. Harper and D. G. Hays. 1-9-59. Unclassified.

A discussion of the progress made on the building of a descriptive grammar of Russian with the complementary efforts of linguists and digital computers. The method of research is described, emphasizing the analysis by which the work of human translators is converted into a program of computer instructions. A computer program for sentence-structure determination is outlined. This program is considered the key to accurate machine translation. 15 pp. Illus. Presented before the UNESCO International Conference on Information Processing at Paris, France, June 18, 1959, and published in the proceedings of the Conference.

P-1589. Economic considerations of space flight ground support requirements. M. A. Margolis and F. S. Pardee. 1-12-59. Unclassified.

A discussion of the economic issues in U.S. space planning, with particular attention to ground facility requirements. The developmental nature of these space programs is indicated, and the resulting importance of estimating total activity requirements in the face of continued program changes is emphasized. Sensitivity testing of these estimates to the more important program parameters is suggested as an aid in planning against the uncertainties involved. 17 pp. Presented before the American Society of Mechanical Engineers at Los Angeles, California, March 9-12, 1959, and published in the proceedings of the Conference.

P-1590. Structural changes in the economy of the Chinese mainland, 1933 to 1952–1957. Ta-Chung Liu. 1-12-59. Unclassified.

An economic analysis of the changes in China that have occurred from 1933 to 1952 through 1957. During this period the output of producer goods has greatly increased. The sacrifice has had a telling effect on the incentive for production of other than steel and cement. Lack of progress in agriculture and the other old-fashioned sectors of the economy has become a limiting factor to the development of the "modern" sector itself. To solve this problem, stronger compulsion was adopted by the establishment of communes in early 1958. Agricultural and other output under this system may temporarily show an increase. 15 pp. Tables. Published in *The American Economic Review*, May, 1959. Presented before the American Economic Association at Chicago, Illinois, December 27, 1958, and published in the proceedings of the Association.

P-1591. A preliminary model atmosphere based on rocket and satellite data. H. K. Kallmann. 1-12-59. Unclassified.

A presentation of a preliminary model atmosphere for an altitude region between 100 and 800 km. The scientific results obtained from rockets as well as from satellites are used to determine the variation of density with altitude. The pressure and scale height are calculated from the density. The experimental and theoretical results are shown in form of graphs and tables. Because of solar effects, these physical parameters may vary by a factor of two or more. This is about the average uncertainty involved in evaluating the experimental data. 27 pp. Illus. A revised version of RM-2286. Published in *The Journal of Geophysical Research*, June, 1959.

P-1592. A game theory analysis of tactical air war. L. D. Berkovitz and M. Dresher. 1-13-59. Unclassified.

The study of a problem in tactical air war concerned with the allocation at each strike of the tactical forces among such competing air tasks as counterair, air-defense, and support of ground operations. A two-person multimove game is formulated in which the allocation decisions of the combatants represent the moves of the game. The game model assumes that counterair missions destroy enemy forces, air-defense missions reduce the enemy's counterair operations, and support of ground operations contributes to the payoff. The optimal allocations derived from the game-theoretic analysis of this model are described, and possible implications of the results for operational gaming are discussed. 47 pp. Tables. Published in *Operations Research*, September–October, 1959.

P-1593. The problem of the Martian blue haze. A. G. Wilson. 1-12-59. Unclassified.

A discussion of the spectral characteristics of the opacity of the Martian atmosphere. The phenomenon of the "blue clearing" is analyzed, together with the various hypotheses advanced to explain the haze and clearing. New observational data are also reported. 12 pp. Presented before the Lunar and Planetary Exploration Colloquium at Griffith Observatory, Los Angeles, California, January 12, 1959, and published in the proceedings of the Colloquium.

P-1594. A seismic scaling law for underground explosions. A. L. Latter, E. A. Martinelli, and E. Teller. 1-14-59. Unclassified.

Observations indicating that the amplitudes of distant seismic signals from underground nuclear explosions are approximately proportional to the total energy release. It is shown that these observations can be accounted for by a simple model which assumes that the nonlinear region close to the explosion is similar for all explosions and that the linear region transmits only low-frequency waves. 11 pp. Illus. Published in *The Physics of Fluids*, May–June 1959. Presented before the PLOWSHARE Symposium at San Francisco, California, May 13, 1958.

● **P-1595-RC. The effect of Chinese Nationalist military activities in Burma on Burmese foreign policy.** O. E. Clubb, Jr. 1-20-59. Unclassified.

A discussion of the effects of the "Chinese Nationalist Problem" on Burmese actions in the United Nations and on Burma's relations with various countries that were directly or indirectly involved. The presence of the Chinese Nationalist troops in Burma was primarily a problem of Burmese relations with Communist China. From the Burmese viewpoint, Chinese Nationalist activities in Burma did much to discredit American support for the Nationalist regime and obstruct America's Asian policies in general. The Chinese Nationalist affair caused friction between Burma and Thailand, but

the Burmese showed considerably less resentment toward Thailand than toward the United States. In the single instance when Burma felt compelled to bring one of its own important problems before the United Nations, U.N. action did little to strengthen Burmese faith in that international body. 64 pp.

- **P-1596. Some results and problems in stochastic linear programming.** Albert Madansky. 1-19-59. Unclassified.

A description of the results and problems in the ordinary "here-and-now" and "wait-and-see" stochastic linear-programming problems. A general formulation of the "here-and-now" problem is presented, and an approach for solving a special kind of "here-and-now" problem is suggested. 20 pp.

- P-1597. Sequential machines, ambiguity, and dynamic programming.** R. E. Bellman. 1-20-59. Unclassified.

A problem of determining testing procedures that make it possible to transform a sequential machine into a known state starting from an initial situation in which only the set of possible states is given. The concept of ambiguity is introduced to treat this problem, and it is shown how the functional-equation approach of dynamic programming can be applied. 9 pp. Published in the *Journal of the Association for Computing Machinery*, January 1960.

- P-1598. Terms of trade between the Soviet Union and smaller communist countries, 1955 to 1957.** Horst Mendershausen. 1-18-59. Unclassified.

An attempt to determine whether the smaller communist countries suffer price disadvantages in trading with the Soviet Union. Soviet foreign trade data show evidence of price discrimination at the expense of the smaller communist countries in Europe from 1955 to 1957. These countries apparently were not paid particularly well for their goods to make up for the high charges for Soviet exports. Soviet export terms to the satellites were generally less favorable than British import prices and were also less responsive to changes in the latter than were Soviet terms to Free Europe. The limitation of the bargaining freedom of the smaller communist countries is attributed to their peculiar relationship with the USSR, which is in a monopolistic-monopsonistic position. 58 pp. Illus. Also published as RM-2305. Published in the *Review of Economics and Statistics*, May, 1959.

- P-1599. A short history of digital computing in Southern California.** F. J. Gruenberger. 1-26-59. Unclassified.

A speech delivered before the Digital Computer Association at Los Angeles, California, January 17, 1958. The rise of intense activity in high-speed computing in the Southern California area is traced from 1942 to 1957. 16 pp. Published in *Computing News* (145), March 15, 1959.

- P-1600. Inequalities for stochastic linear-programming problems.** Albert Madansky. 8-18-59. Unclassified.

A discussion of the conditions under which an approximate solution to a linear-programming problem is satisfactory (when the "right-hand side" is replaced by its expected value). Conditions are given for the equality of the expected value of the objective function for the optimal solution and the value of the objective function for the approximate solution, together with bounds on these values. In addition, the relation is examined between this problem and a related problem, where an observation is made on the "right-hand side" and the (nonstochastic) linear-programming problem is solved based on this observation. 14 pp. Also published as RM-2287. Published in *Management Science*, January 1960. Presented before the American Statistical Association at Chicago, Illinois, December 28, 1958.

- **P-1601. RAND, a personal view of its history.** R. D. Specht. 10-23-58. Unclassified.

An informal talk presented before a session of the Operations Research Society of America (held at St. Louis, Missouri, October 23, 1958) concerned with "A Decade of Military Operations Research in Perspective." The author's view of the history of Project RAND and The RAND Corporation is given. 26 pp. Published in the *Operations Research*, December 1960.

- **P-1602. Evaluating alternative expenditure programs.** R. N. McKean. 1-27-59. Unclassified.

A discussion of the defense budget and activities to evaluate alternative expenditures for governmental operations. The costs and gains of various programs are discussed, together with breakdowns of cost and indicators of performance in recent budgets and improvements of these performance indicators. The analysis shows that measurements for many governmental operations can be devised

that more closely approximate their value. 24 pp. Incorporated in *Public Finances: Needs, Sources, and Utilization*, published by Princeton University Press, Princeton, New Jersey, 1961. \$10.00. Presented at the Universities-National Bureau of Economic Research Conference on Public Finance at Charlottesville, Virginia, April 10-11, 1959.

P-1604. The economics of invention: a survey of the literature. R. R. Nelson. 1-29-59. Unclassified.

A selective summary of the literature on the economics of invention. Both growing social demand and new scientific knowledge are examined as factors stimulating inventive effort. The comparative importance of the private inventor and the research and development laboratory are appraised. The study stresses the great uncertainties that still surround any inventive effort seeking a significant advance, and investigates how this uncertainty affects management practices in industrial-research laboratories. The general analysis is supported by a number of case studies. 54 pp. Also published as RM-2146-1. Published in *The Journal of Business*, April, 1959.

P-1605. Optimum tolerances of sheet materials for flight vehicles. G. A. Hoffman. 12-31-58. Unclassified.

A method for determining "economically optimum" tolerances in aircraft materials. The procedure consists in (1) evaluating the increased cost of reducing overweight by tightening tolerances and (2) finding the economically reducible overweight—by defining broadly the worth to the operator of one pound of eliminated weight—which in turn specifies an optimum tolerance. 22 pp. Illus. Published in *Western Aviation*, May, 1959.

P-1606. The linear relation between the softening temperature and the melting point of ceramics. G. A. Hoffman and W. J. Knapp. 2-18-59. Unclassified.

An examination of the linear relation between the recrystallization temperature and melting point of metals to determine whether or not a similar situation exists in ceramics. This question is investigated first on the basis of experimental data and second by means of theoretical considerations. Some linear relation in ceramics is apparent, enabling a prediction of the upper temperature limitations of untested ceramics. 16 pp. Illus. Also published as RM-2263. Presented before the American Ceramic Society at Chicago, Illinois, May 20, 1959.

P-1607. The Soviet seven-year plan. Oleg Hoeffding. 2-2-59. Unclassified.

A discussion of the new Soviet Seven Year Plan for 1959-1965 and of Khrushchev's prediction that in fifteen years the USSR will "take the first place in the world not only in total output but also in per-capita production." The United States cannot afford to ignore this objective of output expansion as set forth in Soviet national policy. The feasibility of Soviet industrial and agricultural goals is examined, as well as their import for East-West relations. Khrushchev has good reason to be pleased with the rate at which industrial progress is providing Soviet political strategy with the material means for progressing toward the outcome postulated by Marxism-Leninism. 19 pp. Published in *Foreign Affairs*, April, 1959.

P-1609. A new analytic representation of surface interaction for hyperthermal free-molecule flow, with application to satellite drag. Richard Schamberg. 11-26-58. Unclassified.

A re-examination of the customary analytic representation of the gross effects of the interaction between gas molecules and a solid surface. An alternative model for surface interaction is proposed and is used to calculate force coefficients of flat plate and convex bodies in "hyperthermal" free-molecule flow. Formulae are used to estimate the effects of uncertainty in the surface interaction on the drag of satellites. 15 pp. Illus. Published in the *1959 Heat Transfer and Fluid Mechanics Institute—Reprints of Papers*, Stanford University Press, Stanford, California, 1959. \$7.50. Presented before the 1959 Heat Transfer and Fluid Mechanics Institute at Los Angeles, California, June 11, 1959.

P-1610. On adaptive control processes. R. E. Bellman and R. E. Kalaba. 4-8-59. Unclassified.

Part of a broader investigation concerned with the development of adaptive controllers. An attempt is made to show how the functional-equation technique of dynamic programming can be used to formulate and solve a variety of optimization problems involved in the design of adaptive devices. The study discusses the closely allied problems of formulating adaptive control processes in precise

mathematical terms and of presenting feasible computational algorithms for determining numerical solutions. Some areas requiring additional research are indicated. 33 pp. See also P-1948. Published in the 1959 IRE National Convention Record, Part 4.

P-1611. Secular variation in the inclination of the orbit of earth satellite (1957 β) and air drag. L. N. Rowell and M. C. Smith. 2-6-59. Unclassified.

A discussion of the drag acceleration normal to the satellite orbit plane due to the rotating of the earth's atmosphere. 5 pp. Presented before the Tenth International Astronautical Congress at London, England, August 31–September 5, 1959, and published in the proceedings of the Congress.

P-1612. Heat transfer from a nonisothermal disk rotating in still air. J. P. Hartnett. 2-10-59. Unclassified.

An examination of the influence of surface-temperature variation on the heat transfer from a disk rotating in still air. The temperature difference between the disk surface and the fluid at rest is allowed to vary as a power function of the radius. 12 pp. Illus. Published in the *Journal of Applied Mechanics*, December 1959.

P-1613. Dynamic programming, invariant imbedding, and two-point boundary value problems. R. E. Bellman. 2-10-59. Unclassified.

A discussion of how certain uniform techniques based on functional equations can be used to provide new analytic approaches to questions involving ordinary and partial differential equations with conditions at various points or at several boundaries. Computational algorithms are presented which are far better adapted to modern-day computers than those of classical analysis. The paper attempts to replace multi-point boundary value problems by initial value problems. 29 pp. Presented before the Mathematics Research Center at Madison, Wisconsin, April 21, 1959.

P-1614. Invariant imbedding, random walk, and scattering—II: discrete versions. R. E. Bellman and R. E. Kalaba. 2-12-59. Unclassified.

An extension of P-113, *Random Walk, Scattering, and Invariant Imbedding—I: One-dimensional Discrete Case*, which applies the techniques of invariant imbedding to various random-walk processes and to questions of scattering theory. The present paper shows how the ideas presented in the earlier study enable multidimensional, time-dependent, and energy-dependent processes to be treated. A remarkable formal equivalence holds in all of these cases, with the result that the same equations occur repeatedly in different variables. Both new analytic and new computational approaches are achieved. Only the discrete versions of these processes are considered. 19 pp. See also P-1858 and P-2202. Published in the *Journal of Mathematics and Mechanics*, May 1960.

P-1615. Communications and control requirements in the Air Force logistics system. M. A. Geisler. 2-12-59. Unclassified.

A discussion of the role of the communications and control system in Air Force logistics as one of the tools available to Air Force management in attaining its goals for future weapon systems. The operational setting within which communications and control systems must be developed is examined. The present status and future outlook of these systems are presented, and the use of simulation is described as a research tool for studying communications and control systems. 19 pp. Presented before the Conference on National Security and Research in Logistics at Ohio State University, Columbus, Ohio, February 5, 1959, and published in the proceedings of the Conference.

P-1616. The Federation of Rhodesia and Nyasaland: a case study in economic development. Stephen Enke. 2-12-59. Unclassified.

A discussion of the adjustments and policy decisions to be made in the next few years in the Federation of Rhodesia and Nyasaland, which in five years of history has had one of the most rapid economic advances of any country during a comparable period since World War II. This paper describes special features of the federal economy, the possibility of sustaining this pace of economic growth, and the maintaining of capital inflows without losing proven comparative advantages. If serious racial tension can be avoided, long-run economic growth seems assured, and every tendency indicates that the black African will obtain increased income, political rights, and social status within the nation. 35 pp. Tables. Published in the *American Economic Review*, June 1960.

P-1617. Experiments in single-point data processing in a controlled environment. J. A. Postley. 2-19-59. Unclassified.

A description of the Logistics Systems Laboratory's approach to the data-processing problem of measuring the advantages of centralized data processing in large organizations. The Laboratory will simulate a large Air Force organization and establish a single-point system that will centralize, as far as possible, data input, processing, storage, and output. The simulation will use people, mathematical models, and machines to represent entire organizations and their activities. This experiment may help to determine how a centralized data-processing system behaves in our controlled environment and what problems are created by handling a multiplicity of data-processing functions at a centralized point. 8 pp. Presented before the joint meeting of The Institute of Management Sciences and the Operations Research Society of America at Las Vegas, Nevada, April 30, 1959.

P-1618. Zero-one matrices with zero trace. D. R. Fulkerson. 2-20-59. Unclassified.

A study of general existence conditions for $n \times n$ zero-one matrix having given row and column sums and zero trace that consist of a set of $2^n - 1$ linear inequalities. These simplify to a set of n linear inequalities in case the row and column sums are monotone together. 13 pp. Illus. Published in the *Pacific Journal of Mathematics*, Fall 1960.

P-1619. An introduction to do-it-yourself satellites. W. W. Kellogg. 2-20-59. Unclassified.

Introductory remarks presented at the Symposium on Possible Uses of Earth Satellites for Life Sciences Experiments at Washington, D.C., May 14-17, 1958. Problems of satellite experiments are discussed: space environment, satellite package costs, and launching difficulties. 5 pp.

P-1620. Nuclear weapons and limited war. T. C. Schelling. 2-20-59. Unclassified.

A presentation of the argument that a distinction, relevant to the process of limiting war, exists between nuclear and non-nuclear weapons; it arises in the "bargaining" relationship between the Soviets and ourselves. The study suggests (1) that the principal inhibition on the use of atomic weapons in limited war may disappear with their first use; (2) that on the occasion of their first use, concern must be given not only to the original objectives of the limited war, but also to the patterns and precedents established and the "nuclear role" adopted; and (3) that it must be determined how the enemy may limit his response to our first use of nuclear weapons and how he may devise a restrained first use himself. 14 pp. Also published as RM-2510. Incorporated in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25.

• **P-1621-RC. Proposal for a "smog tax."** D. M. Fort, W. A. Niskanen, A. H. Pascal, and W. F. Sharpe. 2-25-59. Unclassified.

A smog-tax proposal that would tax each vehicle operator according to his vehicle's total output of air pollutants within the Los Angeles basin. This measure would reduce the total emission of air pollutants from automobile exhausts in the Los Angeles basin to an acceptable level, achieve the desired reduction as soon as possible, minimize the required administrative expense and interference in individual affairs, and treat individuals in different circumstances as equitably as possible. This proposal is also compared with alternative smog-control proposals. 27 pp. Illus.

P-1623. Reliability, quality control, and simulation. A. S. Cahn. 3-2-59. Unclassified.

An examination of the reliability, quality control, and simulation factors affecting an enterprise to determine the interrelationships among the various parameters and the cost and operational effectiveness of the given system. It is concluded that (1) finding the value of reliability or of quality control is complex; (2) simulation helps not only to indicate the complete relationship of reliability and quality control to the specific objectives of an enterprise, but also to obtain the probable reliability of a proposed system; (3) a useful simulation of any large complex enterprise must be carefully designed; and (4) one useful method for designing such a simulation is to use simultaneously a man-machine model and an all-machine model. 15 pp. Presented before the American Society for Quality Control at Cleveland, Ohio, May 26, 1959, and published in the transactions of the convention.

P-1624. Studies in machine translation—8: manual for postediting Russian text. K. E. Harper, D. G. Hays, and B. J. Scott. 11-7-59. Unclassified.

One of a series of papers describing the methods now in use for research on machine translation (MT) at RAND. The present study is intended as a practical guide to editors who refine partially machine-translated text as a basis for linguistic analysis. The posteditors' tasks are to code preferred English equivalents, English structural symbols, and syntactic connections (dependencies). 30 pp. Illus. Also published as RM-2068.

- **P-1625-RC. Some economic features of public education.** J. C. DeHaven. 3-4-59. Unclassified.

A talk presented on March 11, 1959, to the Council of Directors and Supervisors of the Los Angeles City Board of Education. Granting the case for a minimum compulsory education for everyone and public financial support for this minimum education, the desirability of the sole operation of the school system by public entities is questioned. Public financial support of private schools and the freedom of choice of schools by students within the system could bring about an improvement in the quality and productivity of both public and private schools. This improvement could be achieved through the reinstitution of the merit and differential pay system for teachers, ensuring that the skilled, competent people would remain in the school system and that the best young people would be attracted to education as a career. 16 pp.

- **P-1626. Some preliminary scientific findings of the International Geophysical Year.** E. H. Vestine. 2-17-59. Unclassified.

A description of the International Geophysical Year and of some of the principal results to date. In particular, this paper presents an account of the IGY impact on geomagnetism. 24 pp. Illus. Presented before the Institute of Radio Engineers at Los Angeles, California, February 17, 1959.

- **P-1627. Approximation techniques in dynamic programming.** Cecil Hastings, Jr. 3-4-59. Unclassified.

A paper concerned with the numerical solution of the functional equation $f_{i+1} = \min_y [x^2 + 3y^2 + f_i(2x - x^2 - y)]$ over the interval (0,1), as part of a study on numerical methods in dynamic programming. The ideas that led to the solution are also discussed. 15 pp. Illus.

- **P-1628. Comments on electrical power supplies for underground shelters.** J. H. Huth. 3-4-59. Unclassified.

A transcript of a speech presented before RAND's Second Protective Construction Symposium at Santa Monica, California, March 24-26, 1959. The author comments on desirable properties for civilian shelter power supplies and discusses the advantages and disadvantages of several chemical and nuclear systems. 5 pp. Incorporated in R-341. Also incorporated in *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, published by The Macmillan Company, New York, 1961. \$25.00.

- **P-1629. The advantages of functional packaging of electronic equipment.** E. H. Sharkey. 3-5-59. Unclassified.

An examination of the uses of packaging design in the maintenance of electronic equipment. Functional packaging of complicated electronic equipment (i.e., fabrication of block-diagram functions as physically removable packages) is advantageous. The approach eases system modification and the user's difficult line-maintenance problem, improves in-commission status, reduces over-all equipment complexity, and enhances growth capability. 8 pp.

- **P-1630. The bottleneck assignment problem.** O. A. Gross. 3-6-59. Unclassified.

A description of a simple algorithm for solving either of two different bottleneck assignment problems. One problem requires finding an assignment of men to machines in a serial production line to maximize the rate of flow through the line. The other problem requires finding an assignment for parallel production lines (one man per line) to minimize the time to do a given job. The two problems are essentially identical. 10 pp. Incorporated in R-351. Presented before the Symposium on Mathematical Programming at Santa Monica, California, March 19, 1959.

P-1631. Magnetic storms. E. H. Vestine. 3-6-59. Unclassified.

A summary of the present status of our knowledge of magnetic storms. Related phenomena are discussed, such as the Van Allen radiation belt, aurora, and ionospheric disturbances. 19 pp. Illus. Published in *Science*, October 9, 1959.

P-1632. Order of subject and object in scientific Russian when other differentia are lacking. D. G. Hays. 3-11-59. Unclassified.

A study that determines that the order of subject and object in scientific Russian text is an adequate criterion for distinguishing between them when other grammatic properties are ambiguous. 6 pp. Table. Published in *Mechanical Translation*, December 1958.

• **P-1633. The impact of the space age on engineering education.** Benjamin Pinkel. 3-11-59. Unclassified.

Suggestions for augmenting and altering the engineering curriculum to keep pace with rapid scientific advancement. By emphasizing the fundamentals of science and engineering rather than the study in depth of specific hardware or systems, modern training can prepare the engineer for rapid technological changes. 17 pp. Tables.

P-1634. Integration of modeling and simulation in organizational studies. M. A. Geisler. 3-11-59. Unclassified.

A study of military logistics in which a Monte Carlo model is used to formulate a hypothesis about the characteristics of a logistics organization that will significantly reduce the cost of logistics support with no loss in support effectiveness. This hypothesis is developed so that the resulting organization, policies, and information system can be tested in a realistic man-machine simulation and compared with an alternative system. The simulation produces data showing the feasibility and desirability of the proposed organization. An analytical representation of the simulation is constructed to establish the range of parameter values over which the advantages of the proposed system persist. The paper emphasizes the relative roles that can be played by machine models and man-machine simulation in research directed toward designing preferred and compatible organizational structures, policies, and integrated information flows and communications design. 17 pp. Presented before The Institute of Management Sciences at Paris, France, September 7-10, 1959, and published in the proceedings of the Meeting.

P-1635. Some aspects of a personnel program for computer programmers. E. C. DeLand. 3-11-59. Unclassified.

Ideas for the development of a "more effective" computer personnel staff. The thesis is presented that the acceptability standards for new programmers are too low and are going lower, that this is inimical to the best interests of the computing profession, and that this trend should be reversed by paying more for trainees and then paying more attention to their development and promotions. 13 pp. Presented before the Beckman/EASE Symposium on "Management Integration of Entire Computing Facilities" at Los Angeles, California, February 11, 1959.

P-1636. Some weight considerations for manned lunar missions. H. B. Schechter. 3-1-59. Unclassified.

An investigation of the total weight requirements for three possible types of manned round-trip soft-landing lunar missions, each starting from a space station circling the earth at an altitude of about 350 miles. The first and second missions follow direct-hit flight trajectories and use chemical and nuclear powerplants, respectively. The third mission uses a nuclear powerplant as a sort of "ferry boat" to reach a circular orbit around the moon, while for the landing and ascent portions at the moon, the final payload is propelled by chemical rockets. 25 pp. Illus. Published in the *ARS Journal*, February 1960.

P-1637. The design of large-area astronomical objects. G. A. Hoffman. 5-1-59. Unclassified.

An attempt to define the criteria and problems to be encountered in large-area construction for space exploration. Possibilities of configurations, materials, and shape-retention techniques are discussed from considerations of weight/area ratio, function, storage, lifetime, and economics. Weight estimates for several objects indicate that material properties and choice of shape can affect weight to a considerable extent. 21 pp. Illus. Published in *Aerospace Engineering*, July 1959. Presented before the Institute of the Aeronautical Sciences at Los Angeles, California, June 16-19, 1959.

P-1638. The application of random sampling simulation to reliability estimating.
S. I. Firstman. 4-16-59. Unclassified.

A discussion of the applicability of random sampling simulation to the problem of predicting "drift" failures. Drift failures are defined as system malfunctions occurring because the entire system, with its many interdependencies, performs at a level outside design limits. In particular, the study applies the Monte Carlo method to the problem of predicting system performance based on component performance data and subsystem or "black-box" performance data. The technique permits the integration into one model of all known stresses—environmental and operational—and other events affecting the system operation. Therefore, for a properly designed and executed Monte Carlo experiment at any level of aggregation, the derived performance estimates will be unbiased estimates of the actual system performance. 27 pp. Illus. Presented before the Third Exploratory Conference on Missile Model Design for Reliability Prediction at White Sands Missile Range, White Sands, New Mexico, April 20-24, 1959, and published in the proceedings of the Conference. Also presented before the joint meeting of The Institute of Management Sciences and the Operations Research Society of America at Las Vegas, Nevada, May 1, 1959.

● **P-1639. Sources, availability, and estimated costs of propellants.** S. H. Dole and
M. A. Margolis. 3-15-59. Unclassified.

An outline of the cost and availability criteria pertinent to the selection of a propulsion system, and in particular a propellant combination, for a given application. An attempt is made to indicate what significant relationships and differentiations can be made on the basis of present knowledge. Tables of propellant availability and cost in the United States are discussed. 23 pp. Illus. Incorporated in *The Chemistry of Propellants*, published by the Pergamon Press, New York, 1960. \$10.00. Presented at a special colloquium on the Chemistry of Propellants at Paris, France, June 12, 1959.

P-1640. Defense planning and organization. A. C. Enthoven and H. S. Rowen.
7-28-59. Unclassified.

A discourse on the organization of the Department of Defense, covering the assignment of its roles and missions and the mechanisms through which the business of defense is conducted. The shortcomings of the present organization for handling allocation problems are examined, and some proposals for reorganization are presented. 55 pp. Tables. Presented before the Universities-National Bureau of Economic Research Conference at the University of Virginia, Charlottesville, Virginia, April 10-11, 1959, and published in the proceedings of the Conference.

P-1641. The communist world of Mr. Lippman. Myron Rush. 3-17-59. Unclassified.
A review of Walter Lippman's account of the Communist world (based on his visit to the USSR last October and published in *The Communist World and Ours*, Little, Brown & Co., New York, 1959). Mr. Lippman finds the most pressing issue between the Communist world and the United States to be the Russian and Chinese challenge for the leadership of Asia and Africa, because the main power of the Communist states lies in countries that are economically undeveloped. He believes that the Soviet Union and Red China will use their military power as an instrument of policy to complete their domination of these countries. Flaws in Mr. Lippman's analysis and predictions and in the policy he recommends are discussed. 10 pp.

P-1642. A comparison of random and periodic data sampling for the detection of signals in noise. David Middleton. 2-1-59. Unclassified.

An analysis, by means of probability theory, of the effect of using random rather than periodic data sampling in radar detection systems. In the specific examples examined, it is found that periodic sampling gives the better performance. 31 pp. An abridgment of RM-2124. Published in the *Transactions of the 1959 International Symposium on Circuit and Information Theory*, held at the University of California at Los Angeles, June 16-18, 1959.

P-1643. Functional equations and successive approximations in linear and nonlinear programming. R. E. Bellman. 3-18-59. Unclassified.

An illustration of the applicability of functional equations and successive approximations to various classes of multidimensional maximization problems. The advent of the modern digital computer makes it particularly appropriate that this synthesis of new and old be made. By suitably combining classical and modern devices, many challenging, complex, and significant problems can be solved. 38 pp. Published in the *Naval Research Logistics Quarterly*, March 1960.

P-1644. Partitioning methods in latent class analysis. Albert Madansky. 3-6-59. Unclassified.

A method for obtaining estimates of the parameters of the latent-class model based on first classifying individuals into "latent classes." Properties of the estimates and implications to the identifiability problem are discussed. An example is given of the use of the partitioning method as contrasted with the determinantal method. 31 pp. Tables.

P-1645. An approximation method for large-angle scattering of high-energy scalar and vector waves. W. M. Brown. 3-18-59. Unclassified.

A study that presents an approximation method for large-angle scattering of high-energy scalar and vector waves. Part I develops an approximation method for evaluating large-angle scattering that reduces the problem of computing the scattering amplitude from a volume integration to a single quadrature. Part II extends the modified W.K.B. formulation for the scattering of scalar waves to the problem of vector-wave scattering. 79 pp. Illus.

P-1646. New directions in mathematical programming. G. B. Dantzig. 9-21-59. Unclassified.

An introductory talk for the RAND Mathematical Programming Symposium, held at Santa Monica, California, March 16-20, 1959. The paper reviews the practical and theoretical developments of linear programming during the past 12 years and discusses the current extensions of this tool into areas of special structures, discrete programming, network theory, nonlinear programming, and uncertainty. 12 pp. Published in the *Proceedings of the Second International Conference on Operational Research, Aix-en-Provence, France, 1960*. \$16.20.

● **P-1647. Future science and technology of the USSR.** F. J. Krieger. 1-21-60. Unclassified.

An analysis of the basis for the Soviet Union's recent technological upsurge and of the direction it will take in the future. Soviet science and technology have been mobilized to challenge and to compete with, but not to cooperate with, the rest of the world. Soviet leaders acknowledge that the massive build-up of economic strength planned for the next seven years is predicated on the successes of Soviet scientists in mechanics, physics, chemistry, electronics, automation, and biology. The Soviet regime is fanatically dedicated to the proposition that Soviet man will be first in space, first on the moon, and first in interplanetary communications. 27 pp. Presented at the Air War College, Maxwell Air Force Base, Alabama, March 31, 1959. Also presented at Hq ARDC, Andrews Air Force Base, Washington, D.C., January 27, 1960.

P-1648. Toward a theory of strategy for international conflict. T. C. Schelling. 5-8-59. Unclassified.

A study of the theory of conflict to determine rules of "correct" behavior in a contest-winning sense. This theory may be of interest because (1) we are all participants in international conflict, (2) an understanding of the principles of "correct" play may aid in the study of actual behavior, and (3) knowing how the variables subject to our control can affect the conflict of others may be useful in controlling or influencing the behavior of others. This theory may serve to develop unifying interpretations of conflict behavior. 43 pp. An abridgment of RM-2515. Incorporated as Chapter I in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25. Presented before the International Relations Conference at Northwestern University, Evanston, Illinois, April 8-10, 1959.

P-1649. The gains to India from population control: some money measures and incentive schemes. Stephen Enke. 6-3-59. Unclassified.

A study on population growth in India that attempts to estimate the value of permanently preventing a birth, to outline one incentive scheme for husbands and another for wives to reduce births, and to assess the impact of these schemes on the economy's resources and the government's finances. Overpopulation is perhaps the most serious problem confronting the world today; and, in India's case, the time appears to be opportune for considering the institution of a governmentally sponsored birth-control program. 29 pp. Tables. Published in *The Review of Economics and Statistics*, May 1960.

P-1650. The interpretation and computation of axisymmetric head waves. H. A. Lang. 1-22-60. Unclassified.

An application of the physical requirement of continuous displacements to the evaluation of two elliptic integrals, the imaginary members of which represent, in part, the component displacements of head waves (refraction arrivals) in the problem of the seismic surface pulse. The method is a preliminary step in the development of superposition techniques for axisymmetric wave fields in bounded elastic media. 83 pp. Illus. See also P-1498, P-1755, P-2054, and P-2215.

P-1651. Augmentation of nuclear-rocket specific impulse through mechanical-electrical means. Martin Goldsmith. 3-30-59. Unclassified.

An attempt to calculate the augmentation of specific impulse possible for some realistic propulsion-system designs through the use of a gas-heating cycle suggested by J. Ackeret. The large permissible expansion ratio available to a rocket in space is exploited to obtain a quasi-isothermal expansion of the exhaust gas in a series of turbines. 7 pp. Illus. Published in the *ARS Journal*, August, 1959.

P-1653. Functional equations and theta-functions—I. R. E. Bellman. 3-30-59. Unclassified.

A method for obtaining the classical algebraic relations connecting theta-functions. Since the method depends only on the defining functional equations, it can be applied to theta-functions of higher dimension. 5 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, June 1959.

P-1654. On the strength of fine wires. F. R. Shanley. 4-1-59. Unclassified.

A theory in which the extremely high tensile strength of very fine wires is explained. A model is used consisting (1) of a "core" of material in which slip occurs at nominal tensile stress, and (2) of a very thin "skin" in which it is necessary to develop an extremely high tensile stress to produce surface slip. A mathematical formula is derived which predicts test results with good accuracy. The role of dislocations in the theory is discussed. 24 pp. Illus. A revision of RM-2011.

P-1655. Design and cost considerations for high-altitude aircraft systems. T. F. Cartaino. 3-10-59. Unclassified.

A review of the significant design factors for subsonic aircraft with nonafterburning turbojet engines for high-altitude patrol or endurance flights. The paper discusses the design limitations imposed by the current state of the art, the interaction between cost and possible operational requirements, and the possibilities for improving altitude performance. 21 pp. Illus.

P-1656. The use of simulation in estimating intrasquadron logistics requirements: a description of LP-II, phase 1.1. W. W. Haythorn. 2-17-59. Unclassified.

A discussion of LP-II, Phase 1.1, which simulates a decentralized squadron living on a host base and governed by policies now being developed by the Air Force to evolve alternative logistics systems for the ICBM force. The study simulates the policies for Phase 1.1, the missile hardware system from 1963 to 1965, and data on support units and squadron management. The events that initiate action in the system are given, as well as an example of a typical "remove and replace" sequence. System-effectiveness data, system-cost data, and decision-process data are analyzed, and the expected outputs of Phase 1 are described. 22 pp.

P-1657. Protection of communications and electronic systems. F. R. Eldridge. 4-13-59. Unclassified.

An examination of many problems encountered in providing protected communications and electronic facilities for superhard sites. The growing wartime threats to communications and electronic systems may be met (1) by using many different types of communication systems that are independently vulnerable to the various methods that could be used to disrupt them and (2) by requiring hardening as well as dispersal. 13 pp. Illus. Incorporated in R-341 (out of print). Also incorporated in a book entitled, *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, published by The Macmillan Company, New York, 1961. \$25.00. Presented before the Second Protective Construction Symposium at Santa Monica, California, March 24, 1959.

P-1659. An improved solution for the motion of bodies in free fall. H. B. Schechter. 4-3-59. Unclassified.

An analysis of the vertical motion of a spherical body falling freely through an isothermal atmosphere. The assumption of a constant drag coefficient is abandoned in favor of a drag coefficient. An analytic expression is fitted to the curve of C_D versus M , and the resultant nonlinear equation of motion is solved by an iterative technique, leading to a better representation of the variation of velocity with altitude. 17 pp. Illus.

P-1660. Is defense spending wasteful? H. S. Rowen. 6-1-59. Unclassified.

Arguments stressing that, especially in the thermonuclear age, the weapons we buy contribute to our welfare. This view is independent of the level of our defense spending. It applies to any level of budget, and to decreases as well as increases. We should be careful that when the term "waste" is applied to defense, it is used with precision. There are many different ways in which the economy benefits from defense. We should be conscious of the risks of not carrying out a large defense program as we enter the sixties. 7 pp. Published in *Challenge Magazine*, June 1959.

P-1662. Effects of a meteoroid impact on steel and aluminum in space. R. L. Bjork. 12-16-58. Unclassified.

An estimate of the effects of a collision between an individual meteoroid and a component of a space vehicle. The effect of impact at meteoric velocities is calculated from fundamental principles. 26 pp. Illus. Presented before the Tenth International Astronautical Congress at London, England, August 28, 1959, and published in the proceedings of the Congress.

P-1663. On the limit of solutions of differential-difference equations as the retardation approaches zero. R. E. Bellman and K. L. Cooke. 4-9-59. Unclassified.

An attempt to show that in the study of the limiting behavior of the solutions of certain differential-difference equations, the more accurate description yields an easier problem than the obvious approximation, which yields a more difficult problem. A typical result and sketch of proof are presented. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, July 1959.

P-1664. General convex objective forms. G. B. Dantzig. 4-9-59. Unclassified.

A study concerned with the minimization of a general convex objective form subject to linear inequality restrictions. An alternative procedure is developed that has points in common with those given in P-1544 on the decomposition principle for linear programs. The general convex objective form, however, leads to an infinite algorithm and requires a special proof of convergence. The special devices used in the proof can also be applied to show convergence of the simplex algorithm for infinite programs. 19 pp. Published in *Mathematical Methods in the Social Sciences*, ed. by Kenneth J. Arrow, Samuel Karlin, and Patrick Suppes, Stanford University Press, Stanford, California, 1959.

• **P-1665. A discussion of several concepts used in the optimization of control systems by dynamic programming.** F. T. Smith. 5-13-59. Unclassified.

The application of dynamic-programming techniques to the optimization of control systems. The concepts of the state of a controlled element and the transition matrix are used to describe the behavior of the controlled element. The paper discusses various types of performance indexes or error criteria used to measure controlled element performance. The examples given involve the optimization of a simple linear sampled data servo system and an application to a controlled element, the behavior of which is described by the Van der Pol equation. 54 pp. Illus. Presented before the Graduate Seminar in Control Systems Theory at the University of California at Los Angeles, April 29, 1959.

P-1666. A lower bound for the critical probability in a certain percolation process. T. E. Harris. 4-10-59. Unclassified.

A study that considers the lattice in the Cartesian plane consisting of all points (x, y) such that either x or y is an integer (positive, negative, or zero). The sides of the unit squares are called links. Each link is designated "active" with probability p or "passive" with probability $1 - p$, independently of all other links. It is shown that if $p = 1/2$, then the probability is 0 that there is a connected infinite set of active links. 20 pp. Published in the *Proceedings of the Cambridge Philosophical Society*, January 1960.

P-1667. The secant method for simultaneous nonlinear equations. P. S. Wolfe. 4-15-59. Unclassified.

A procedure for the simultaneous solution of a system of not-necessarily-linear equations that consists in a generalization of the secant method for a single function of one variable. 7 pp. Published in the *Communications of the Association for Computing Machinery*, December 1959.

- **P-1668. The Export-Import Bank and development lending.** M. W. Hald. 4-15-59. Unclassified.

A review of the evolution of the policies and operations of the Export-Import Bank (the principal agency of the United States Government engaged in international finance) as a basis for evaluating its appropriateness as a development loan agency to aid underdeveloped countries. The success of the Export-Import Bank is attributed directly to its unique concentration on the problem of promoting U.S. foreign trade. However, the author believes that the peculiar needs of a development loan agency could not be met by this bank without a fundamental reorientation of its philosophy and policies. 23 pp. Tables.

P-1669. Space flight for man. R. W. Buchheim. 4-15-59. Unclassified.

A study of some nonmilitary implications of space flight for man. The limited but important role that private philanthropy can play in a primarily government-directed and -financed operation is discussed. Some of the future uses of observation satellites are outlined, and astronautics is heralded as opening the "experimental phase of astronomy." 8 pp. Presented before the Conference of Southwest Foundations at Santa Fe, New Mexico, April 17, 1959.

P-1671. Lunar exploration by photography from a space vehicle. M. E. Davies. 3-5-59. Unclassified.

A description of a camera that, as a payload of an early space vehicle, could photograph the moon. The resulting pictures should be superior to those obtained by telescope or by television cameras such as those carried by Pioneer I and II. Trajectories, spin stabilization, film, lenses, and other factors are considered. 25 pp. Illus. A supplement to P-1892. See also P-1969. Published in the *Proceedings of the Tenth International Astronautical Congress, London, 1959*, Springer-Verlag, Wien, 1960.

- **P-1672. Measuring the reliability of equipments in operating environments.** D. S. Stoller. 4-21-59. Unclassified.

A discussion of some of the concepts and problems applicable to the measurement of reliability. This term is described as encompassing a probability, an aggregate, an environment, a set of criteria, and a time interval. The interdependence of these reliability factors on operations, maintenance, and supply actions related to the equipments is examined from the viewpoint of designing a reliability measurement system. 8 pp. See supplement P-1810. Presented before a meeting jointly sponsored by the Operations Research Society of America and The Institute of Management Sciences at Las Vegas, Nevada, April 21, 1959.

P-1673. Recurrent events in a Bernoulli sequence. M. B. Marcus. 3-21-60. Unclassified.

A description of the "point of regeneration" method used to obtain simple, sequential equations for determining the complete probability density function for multiple occurrences of events in a Bernoulli sequence. Both the independent and overlapping classes of recurrent events are included in the general framework of these equations. The equations also lead to the generating function for the probability distribution which is used to obtain the expected recurrence times for the different classes of recurrent events. The methods and results of this study are applicable to problems in automatic control, communications, and information processing. 18 pp. Published in the *IRE Transactions on Information Theory*, December 1959.

P-1674. First-order error propagation in a stagewise smoothing procedure for satellite observations. Peter Swerling. 2-18-59. Unclassified.

A method of smoothing observational data (using variations of the classical method of minimizing a quadratic form in the residuals) in cases where observations are determined by the time of observation plus a finite number of parameters, called elements. The object of this stagewise procedure is to estimate the elements. The first-order dependence of errors in estimates on the observation errors is established. Applications to estimation of earth-satellite orbits are discussed. 28 pp. Also published as RM-2329. Published in *The Journal of the Astronautical Sciences*, Autumn 1959.

P-1675. Why go deep underground? P. M. Dadant. 4-20-59. Unclassified.

A paper that discusses the general nature and likelihood of thermonuclear war, the threat of such a war, and the need for seriously preparing not only to deter a war, but also to be able to fight one. These considerations are then related to the specific problem of the NORAD Combat Operations Center. 21 pp. Incorporated in R-341. Also incorporated in *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, published by The Macmillan Company, New York, 1961. \$25.00. Presented before a meeting on the design of a hardened NORAD Combat Operations Center, held at Colorado Springs, Colorado, April 20, 1959.

P-1676. The cooling problems of chemical and nuclear power plant application to a class of large shelters. W. R. Elswick. 4-24-59. Unclassified.

A discussion of electrical power supplies for large shelters and the associated problems of air breathing and heat removal. The shelter application is considered for a hypothetical military command center or early warning center. 12 pp. Tables. Incorporated in R-341 (out of print). Also incorporated in *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, published by The Macmillan Company, New York, 1961. \$25.00.

P-1677. Codes for the correction of "clustered" errors. S. H. Reiger. 4-21-59. Unclassified.

A method for the systematic construction of codes in any length that are capable of error-free transmission if errors occur in clusters of a prescribed duration. Relatively easily implemented codes and straightforward coding operations are examined, and applications to teletype transmission are discussed. 23 pp. Illus. Published in *IRE Transactions on Information Theory*, March 1960.

P-1678. An approximating algorithm for an optimum aim-points problem. S. I. Firstman. 4-22-59. Unclassified.

An algorithm that will yield approximate solutions in integers for the problem of assigning missiles to aim points so as to maximize the resultant expected target destruction. The target complex is such that a weapon aimed at one target can destroy another, or a weapon aimed between several targets can destroy more than one. A precise statement of the algorithm and an example of its use are given. 28 pp. Illus. Published in *Naval Research Logistics Quarterly*, June 1960. Presented before the Operations Research Society of America at Washington, D.C., May 14-15, 1959.

P-1679-RC. Some observations on political gaming. H. Goldhamer and H. Speier. 4-30-59. Unclassified.

A discourse on the technique of experimental political gaming and some observations on the use of such games. Certain political games played at RAND are described, and the value of the game procedure is assessed. Payoffs of political gaming discussed are its usefulness as an educational device, in testing strategy prior to the test made by history itself, and in indicating problems for further research. In addition, a few variants in the form and content of the game are listed that any thorough exploration of this procedure ought to test. 27 pp. Published in *World Politics*, October, 1959.

P-1680. Triangle: man, machine, space. Irwin Cooper. 4-29-59. Unclassified.

A discussion of man-machine relations to determine the present role of this science in space flight. Some of the physiological factors involved in space operations are examined to show what partition or merging of men and machines is indicated in space vehicles; and a philosophical viewpoint is presented, describing functional areas to which men or machines can be assigned. The use of intelligent simulation techniques is suggested for obtaining and processing data from experimental man-machine systems. Systematic and consistent consideration of the physiological factors concerned with space travel is necessary for reliable human input data. 20 pp. Table.

P-1681. Some comments on the wave propagation study group. S. M. Genensky. 4-29-59. Unclassified.

An examination of some of the views and findings of a group that met at Santa Monica, California, March 24-26, 1959, in connection with the RAND-sponsored Second Symposium on Protective Construction, to discuss the problems of wave propagation through geological media. An attempt is made to evaluate the findings of greatest significance. 10 pp. Incorporated in R-341 (out of

print). Also incorporated in *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, published by The Macmillan Company, New York, 1961. \$25.00.

P-1682. Review of United Nations, Department of Economic and Social Affairs, *The development of manufacturing industry in Egypt, Israel, and Turkey*. Harold Lubell. 6-4-59. Unclassified.

A review of *The Development of Manufacturing Industry in Egypt, Israel, and Turkey*, a report of the Department of Economic and Social Affairs of the United Nations. This outstanding report should be the starting point for any future study on industrialization in these countries. The study examines the position of the manufacturing industry in these Middle East countries in relation to the rest of the economy, describes the manufacturing sector from numerous angles, and discusses some of the factors that will determine the future course of their economic development and industrialization. 4 pp. Published in *Kyklos*, Vol. XII, No. 4, 1959.

P-1683-RC. A discussion of *Report on a study of non-military defense*. H. H. Mitchell, M.D. 4-30-59. Unclassified.

A description of a RAND report on non-military defense and of the philosophy involved in its approach. An attempt is made to determine whether a civil defense program is feasible, and if a feasible program can be devised, whether a plausible case can be made for implementing it. The study concludes that civil defense is both feasible and plausible and suggests that a minimal shelter program be started immediately, that a large-scale program be made ready on a crash basis if necessary, and that research studies be undertaken where current knowledge is uncertain. 19 pp. Illus. Presented at a Mass Casualty Course, Army Medical School, Brooke Army Medical Center, at Fort Sam Houston, Texas, April 27, 1959.

P-1684. A note on the computation of single-sideband peak power. W. K. Squires and E. Bedrosian. 5-6-59. Unclassified.

A description of an approach that permits simple and direct computation of the average-to-peak SSB (single-sideband) power for a continuous range of modulating signals from sinusoidal to square waveforms. 7 pp. Illus.

P-1685. The aggregation of servicing facilities in queueing processes. J. W. Hooper and D. S. Stoller. 5-12-59. Unclassified.

A paper concerned with the problem of finding the conditions under which individual service facilities should be aggregated to perform a certain workload in an optimal way, on the basis of whether personnel should work as individuals or teams. This is a problem of widespread application to the many production or repair activities characterized by a stochastic flow of workload units through a service facility. The problem does not yield to intuitive reasoning, since the decision depends on the value of the parameters of the distributions involved as well as on the efficiency of the team. The basic model used is the standard queueing model with an infinite population of units whose arrival at the service facilities and whose servicing are characterized by a Poisson distribution. 11 pp. Illus. Presented before the Sixth Annual International Meeting of the Institute of Management Sciences at Paris, France, September 1959, and published in the proceedings of that meeting.

P-1687. Uncertainty, prediction, and competitive equilibrium. R. R. Nelson. 5-16-60. Unclassified.

A study of the relationship between the ability of the firms of a competitive industry to predict demand and the parameters of competitive equilibrium. The author discusses first a competitive firm facing a varying price and then a competitive industry facing a varying demand curve. It is assumed that cost curves and the frequency distribution of demand are given. The manner in which varying the ability to predict affects a number of the parameters of competitive equilibrium is examined. It is found that the ability to predict affects profits or quasi rents, the elasticity of the ex-post supply curve, average industry output and average industry price in long-run equilibrium, and the variation in market price generated by a given variation in market demand. 28 pp. Illus. Published in the *Quarterly Journal of Economics*, February 1961.

- **P-1688. Outer space and the international scene.** J. M. Goldsen. 5-6-59. Unclassified.
A discussion of the possible consequences and meaning of technical achievements in space from many viewpoints (namely, political, military, economic, legal, scientific, and psychological). The paper reviews the current "space diplomacy" of the Soviets and the results of their campaign and summarizes the political strategies and tactics that the United States should use to further its national space objectives. 16 pp. Presented before the First World Congress of Flight at Las Vegas, Nevada, April 17, 1959.

P-1689. The use of numerical simulation in the development of inventory policy.
H. S. Campbell. 5-6-59. Unclassified.

A discussion of the role of numerical simulation in the development of inventory policy. Numerical simulation is a computational program, reproducing the structure of a real-world organization, or of a simplified model of the organization. The advantages and disadvantages of analysis by simulation are described, as well as a random-sampling simulation model of an inventory system. This model is applied (1) to the effect on the costs of operating an inventory system when severe initial uncertainty exists concerning the mean demand rate or other demand characteristics and (2) to the effect of the inefficiencies resulting from the use of statistical estimates as the basis for setting stock levels. 13 pp. Presented before the Conference on National Security and Research in Logistics at Ohio State University, Columbus, Ohio, February 5, 1959, and published in the proceedings of the Conference.

- **P-1690. A macro analysis of military air transportation.** W. A. Niskanen. 5-6-59. Unclassified.

A discussion of the use of various programming techniques to determine the nature and magnitude of the major military airlift missions and the best mix of airlift resources to perform these missions. The RAND study of military airlift examines the strong trade-off between flying hours and fleet composition, the potential contribution of the commercial fleet in the context of planning for the military fleet, and the separation of mission requirements into discrete periods to permit evaluation of the imputed cost of airlift in different periods. 7 pp. Presented before the joint meeting of the Operations Research Society of America and The Institute of Management Sciences at Las Vegas, Nevada, April 30, 1959.

P-1691. The mathematical theory of control processes. R. E. Bellman. 5-7-59. Unclassified.

A description of the mathematical theory of control processes, a new branch of mathematical analysis. The various types of control processes are discussed: deterministic, stochastic, and adaptive. The kinds of mathematical techniques applied to their study are examined. These techniques include the classical calculus of variations and modifications, dynamic programming, and the theory of games. 33 pp. Illus. Incorporated in *Modern Mathematics for the Engineer*, published by McGraw-Hill Book Company, Inc., New York, 1960. \$9.50.

- **P-1692. The content of economics.** M. W. Hoag. 5-8-59. Unclassified.

A brief sketch of economics for operations researchers. Its definition, scope, limitations, and potential contributions to operations research are discussed. The contributions are the perception of fruitful analogies, some precepts, and a better understanding of the criterion problem derived from the economics of welfare. 11 pp. Presented as part of a panel discussion to the Operations Research Society of America at Washington, D.C., May 15, 1959.

P-1693. Main street and Mars. R. A. Davis. 5-1-59. Unclassified.

An informal presentation to the ladies of the Shakespeare Club at Ontario, California, May 1, 1959. What is known about Mars, and the possibility of exploring it in the foreseeable future, is discussed. 17 pp.

P-1694. Pitfalls in analysis. E. S. Quade. 2-6-59. Unclassified.

An examination of the pitfalls in systems analysis and of the ways to avoid these pitfalls. The paper stresses that problem formulation is crucial; that analysis should be an iterative process and should create as well as eliminate alternatives; that inquiry and optimization cannot be complete; and that the question, not the model, is important. 15 pp. Presented before the National Logistics Conference at Ohio State University, Columbus, Ohio, February 6, 1959, and published in the proceedings of the Conference.

P-1695. Some interior problems of hydromagnetics. J. D. Cole and J. H. Huth. 5-8-59.

Unclassified.

An investigation of the static boundary problems of line currents and dipoles immersed in a perfectly conducting static fluid, and of the perturbing effect of moving fluid on the magnetostatic boundary about an isolated line current. The initial circular boundary is distorted into an ellipse with major axis transverse to the direction of flow. 12 pp. Illus. Published in *The Physics of Fluids*, November–December 1959.

- **P-1696. An analytical model for developing optimal ballistic missile maintenance procedures.** E. E. Bean and W. H. McGlothlin. 5-13-59. Unclassified.

An analytical model to determine the probability that the missile system is in an alert condition and that it will survive the countdown and launch phase with 0, 1, 2, . . . , n delays of known duration. Both of these aspects are examined for several sets of maintenance schedules and operational modes, allowing a determination of the set of conditions producing a maximum probability of a successful launch within a fixed period of time. When used in conjunction with vulnerability considerations, this model is a useful tool for obtaining the relationship between mode of operation, maintenance policy, and system effectiveness. 23 pp. Illus. Presented before the joint meeting of the Operations Research Society of America and The Institute of Management Sciences at Las Vegas, Nevada, April 30, 1959.

- **P-1697. A broad look at the performance of infrared detectors.** R. W. Gelinas and R. H. Genoud. 5-11-59. Unclassified.

A discussion of the capabilities of present-day infrared detectors in terms of radiant power and time. The method of presentation gives quickly an approximate value for the minimum detectable power of practically any detector at any infrared wave length. This study may serve as an aid in evaluating novel schemes of infrared detection. 41 pp. Illus. Presented before the Infrared Information Symposium Specialty Group on Detectors at Syracuse University, Syracuse, New York, June 3, 1959.

- P-1698. Some unique problems in the development of qualified translators of scientific Russian.** R. D. Burke. 5-12-59. Unclassified.

A discussion of the current need in the United States for a greatly increased volume of translation of scientific Russian into English. RAND's course in scientific Russian offered to the technical research staff is outlined, together with some of the problems encountered, methods of instruction used, and conclusions drawn from the presentation of these classes. 9 pp.

- P-1699. A mathematical theory of adaptive control processes.** R. E. Bellman and R. E. Kalaba. 5-11-59. Unclassified.

The construction of a general mathematical framework, using the techniques of the theory of dynamic programming, for application to the study of adaptive control processes. 5 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, August 1959.

- P-1700. Invariant imbedding and neutron transport in a rod of changing length.** R. E. Bellman, R. E. Kalaba, and G. M. Wing. 10-26-59. Unclassified.

A study which uses the method of invariant imbedding to analyze a one-dimensional neutron transport process in which the length of a rod of fissionable material varies in a known way as a function of time. This step is preparatory to one in which Stefan-type problems will be studied through use of invariance principles. 5 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, January 1960.

- P-1702. Space investigation in the USSR: past, present, and future.** F. J. Krieger. 5-15-59. Unclassified.

A study of the practical investigation of space by the USSR. In 1933 the USSR launched the first in a series of liquid-propellant atmospheric research rockets. A government-sponsored rocket-research program was organized in 1934. By 1949 the Soviets had embarked on an upper-atmosphere research-rocket program. In 1957 an intercontinental ballistic missile was successfully tested, and by early 1959 the Soviets had launched an interplanetary rocket. Soviet astronauts will probably plant the insignia of the USSR on the moon by 1967, the 50th anniversary of Communist power

and propaganda. 11 pp. Published in *Astronautics*, July 1959. Presented before the National Telemetering Conference at Denver, Colorado, May 25-27, 1959.

P-1706. On the quantization of meson mass. Arnold Kramish. 5-18-59. Unclassified. A discussion of the empirical relationship suggesting that meson masses are integral multiples of the reciprocal fine-structure constant and the mass of the electron. A deviation from the experimental mass of up to approximately 10 electronic mass units due to the coupling with the electromagnetic field is allowed. It is shown that such a quantization of mass results from a simple consideration of the uncertainty principle and from the assumption that the effective range of the meson-producing forces is a related fraction of the classical electron radius. e^2/mc^2 . 3 pp.

P-1707. Observation satellites: problems, possibilities, and prospects. A. H. Katz. 5-25-59. Unclassified.

A discussion of the operating characteristics and possible roles of observation satellites. The principal data-collection system described is visual photography. Various levels of observation are examined, and the comparative advantages of video transmission of data and physical recovery of a data package are considered. The satellites discussed include the 24-hour satellite and satellites for mapping, meteorological observation, and inspection. 128 pp. Illus. Published in installments in *Astronautics*, appearing in the April, June, July, August, September, and October, 1960, issues. Presented before the International Astronautical Federation Congress at London, England, September 1959.

P-1708. What have computers to do with management? H. A. Simon and A. Newell. 5-21-59. Unclassified.

A study concerned with the capabilities of computers to perform tasks now performed by humans and the conditions that will determine the division of labor between computers and humans in business and other organizations. Automation is being extended to repetitive clerical and computational tasks, to areas where decisions are relatively tangible and quantitative, to routine engineering design, and to problems requiring discovery and synthesis. As technical problems of programming computer activities are solved, the choice between man and computer in performing these activities rests less on feasibility and more on the economic and other consequences of the change. 36 pp. Presented before the Seminar on Information Systems and Their Impact on the Management Organization at the University of Chicago, Illinois, February 12-14, 1959, and published in the proceedings of the Seminar.

P-1709. SPADE, a set of subroutines for solving elliptic and parabolic partial differential equations. M. L. Juncosa and D. M. Young. 7-29-59. Unclassified.

A description of a set of closed subroutines for solving systems of elliptic and parabolic partial differential equations on an IBM-704 computer with enough flexibility in the routines to permit their use on an IBM-709. The SPADE routines will handle systems of partial differential equations in two space-like dependent variables. For parabolic equations the routines will handle one additional time-like variable with several different subregions permitted. The routines will generate the grid points, obtain the coefficients of the linear algebraic equations to be solved, and solve them by successive overrelaxation. 9 pp. Presented before the International Conference on Information Processing, UNESCO, Paris, France, June 15-20, 1959, and published in the proceedings of the Conference.

P-1710. Note on conjugate points of geomagnetic field lines for some selected auroral and whistler stations of the IGY. E. H. Vestine. 5-28-59. Unclassified.

An extension of the Block and Herlofson method for computing field lines as a means of deriving conjugate points of auroral and magnetic stations. The study uses a total of 48 coefficients, the computation being done on an IBM-704. The method used previously by Vestine and Sibley has been extended to 48 coefficients, the latter recently derived by Finch and Leaton. 11 pp. Table. See also P-1726. Published in the *Journal of Geophysical Research*, October 1959.

P-1711. The organization of atomic energy in the USSR. Arnold Kramish. 6-2-59. Unclassified.

A discussion of the organization of atomic energy in the USSR. The paper indicates that the men who administer the Soviet atomic energy program are a unique breed of civil servants of the Soviet

state. Developed over many decades, this high-level cadre of state servants is composed of hardened, devoted Communists combining technical, political, and administrative competence. In addition, the eventual peppering of the USSR with unique scientific communities where fissionable materials and nuclear weapons will be manufactured is a new pattern of development that the West cannot afford to ignore. 19 pp. Incorporated in *Atomic Energy in the Soviet Union*, published by Stanford University Press, Stanford, Calif., 1959. \$4.75. Published in the *Bulletin of the Atomic Scientists*, October 1959.

- **P-1712. Meteors: frequency, size, and depth of penetration.** H. K. Kallmann. 6-3-59. Unclassified.

Numerical data on estimated values for the various velocities and densities that a meteorite can have. Calculations are included based on visual observations by Millman and on Van de Hulst's meteor dust theory. Tables and graphs refer to sporadic meteors only. 14 pp. Illus.

- P-1713. A discussion of the correlation of critical conditions for bare homogeneous reactors.** B. Pinkel and G. B. W. Young. 6-4-59. Unclassified.

A procedure for correlating the critical conditions for bare homogeneous reactors. The procedure is applied to the critical conditions determined from an 18-group analysis for a series of reactors that use H_2O , D_2O , Be, BeO , Li^7H , and C as moderators, and to a few experimental results. The correlation obtained is good and indicates the relation between the properties of the reactor materials and the critical conditions. 25 pp. Illus. Published in *Nuclear Science and Engineering*, December 1961. Presented before the American Nuclear Society at Gatlinburg, Tennessee, June 15-17, 1959.

- P-1714. The Sino-Soviet alliance: how durable?** A. S. Whiting. 6-5-59. Unclassified.

A discussion of various types of tension that may arise in the Sino-Soviet alliance over the next two decades from population pressures, prestige rivalry, and policy conflicts. *Lebensraum* needs will not lead to Chinese colonization of Russian territories, much less to actual war. Prestige rivalry will decrease the willingness of each partner to compromise on matters affecting conflicts of policy interest. China's eventual independence in the manufacture of nuclear weapons may remove one of the most critical of the constraints that presently appear to limit China's freedom to differ with Russian policy and strategy. The West may be an active, rather than a passive, force when disagreements weaken the Sino-Soviet alliance if our policy formulation and implementation are improved. 29 pp. Published in *The New Leader*, October 14, 1959. Presented before the American Political Science Association at Washington, D.C., September 10-12, 1959.

- P-1716. Randomization of threats and promises.** T. C. Schelling. 6-5-59. Unclassified.

An investigation of randomization in non-zero-sum games. In its role of making indivisible objects divisible, or incommensurate objects homogeneous, randomization is relevant to threats and promises. In the illustrations given, a rationale is found for a "fractional threat." The paper also considers whether the tactic of "unconditional commitment" is one that in certain cases can advantageously be made less than certain. 13 pp. Illus. Incorporated in *The Strategy of Conflict*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$6.25.

- P-1717. Review of I.G.Y. upper-air results.** W. W. Kellogg. 6-5-59. Unclassified.

A review of the results of the I.G.Y. upper-atmosphere research program. The troposphere, stratosphere, mesosphere, and ionosphere are discussed, together with some solar-terrestrial effects. 21 pp. Illus. Published in the *Transactions of the American Geophysical Union*, June 1960.

- P-1718. Introduction to photographic instrumentation engineering.** A. H. Katz. 5-1-59. Unclassified.

A discussion of the uses, advantages, and limitations of the photographic method applied to instrumentation engineering, as well as of the working rules governing the interaction of system components. A general matrix is presented in which to examine problems. Predictable future and dramatic applications of photographic instrumentation are noted. 9 pp. Illus. Presented before the Instrument Society of America at Chicago, Illinois, September 21-25, 1959, and published in the proceedings of that Conference.

- P-1719. Civil defense for Williamstown?** P. G. Clark. 6-8-59. Unclassified.

A discussion of the prevailing beliefs that are causing popular apathy in the United States toward civil-defense measures. These beliefs are (1) that the military potential of the USSR and the U.S.

has made all-out war unlikely; (2) that if war did occur, long-term radioactivity would make life impossible on the North American continent; (3) that if the population could be preserved from the effects of war, abhorrent living conditions would make life unbearable; and (4) that the anticipated costs of civil-defense measures are too high. 8 pp. Published in the *Williams Alumni Review*, July 1959.

P-1720. A Russian structure for comparison. D. G. Hays and B. J. Scott. 6-1-59. Unclassified.

A description of a structural approach to determine the specific functions of three Russian sequences in particular sentences. These sequences are used by Russian authors to draw comparisons between objects, properties, or circumstances. 12 pp. Table.

P-1721. Preliminary thoughts about India's Third Five Year Plan. Stephen Enke. 6-10-59. Unclassified.

An attempt to indicate the impending problems of India's economy by an evaluation of India's Third Five Year Plan (1961-1966), which is already under active official consideration. Its provisions include a total planned investment of Rs 10,000 crores, with Rs 6700 crores in the Public Sector, external assistance supposedly limited to Rs 1000 crores, and no deficit financing. The objective of the Plan is to absorb, in gainful occupations, at least all the additional labor force seeking work or self-employment. It is hoped that the Plan will increase the average annual national income by 7 per cent. 30 pp. Tables. Published in the *South African Economic Journal*, June 1960.

P-1722. The Dirichlet functional. H. A. Osborn. 6-11-59. Unclassified.

A study to obtain representations of the Dirichlet norm of a harmonic function on a plane region R in terms of the boundary values of that function. Two such representations are obtained. 80 pp. Illus. Published in the *Journal of Mathematical Analysis and Applications*, June 1960.

● **P-1723. Machine analysis methods for network vulnerability problems.** M. L. Juncosa. 3-25-59. Unclassified.

A review of some optimization problems involving communication networks that are usually of such size as to require a high-speed computer for solution. Some parallelisms and translations between different problems are also illustrated. 25 pp. Illus. Presented before the RAND Second Protective Construction Symposium at Santa Monica, California, March 24-26, 1959.

● **P-1724. Military radio communications equipment trade-offs.** D. C. Ports, J. J. Crenca, K. Heisler (Jansky and Bailey, Inc.), and E. E. Reinhart. 6-12-59. Unclassified.

Part of a broader investigation designed to study all the relationships required for communication-system planning. This paper describes empirical design-cost relationships for military radio-communications equipments, based on the characteristics of existing and developmental systems. Performance-cost trade-off curves illustrating the use of these relationships are also presented. 18 pp. Illus. Presented before the Third National Convention on Military Electronics at Washington, D.C., June 29-July 1, 1959.

P-1725. Experimental design, test, and evaluation of an F-100D flyaway kit. Bernard Okun. 6-16-59. Unclassified.

Part of a broader investigation concerned with flyaway kits, or sets of spare parts that enable squadrons to maintain their own airplanes for a given time period when cut off from outside supply and maintenance. Former RAND studies (RM-1490 and RM-2062) dealt with flyaway-kit tests for the B-47 and F-86H. The present paper describes the history and results of a subsequent kit test for the F-100D. It is hoped that from the F-100D results, even better flyaway kits will emerge. 62 pp. Illus. A revision of RM-2233.

P-1726. Remarks on auroral isochasms. E. H. Vestine and W. L. Sibley. 5-16-59. Unclassified.

An application of an adiabatic invariant governing the motion of charged particles in a magnetic field, discussed by Van Allen, to auroral particles drifting in the geomagnetic field. By calculating the geomagnetic field in space and the drift of the auroral particles, the distribution with latitude and longitude of polar aurora is successfully predicted. The average directions of homogeneous auroral arcs, which vary over the Arctic area, are also successfully explained. Consequent plausible

extensions of the theory of aurora and magnetic storms are mentioned. 6 pp. Illus. See also P-1710. Published in the *Journal of Geophysical Research*, September 1959.

- **P-1727. The summertime reversal of winds in the lower stratosphere.** E. S. Batten. 6-17-59. Unclassified.

A time and space description of the summertime reversal of winds in the lower stratosphere. Above 20 km, a reversal to east winds occurs shortly after vernal equinox and a return to west winds occurs shortly before autumnal equinox. The paper computes as a function of time (1) the daily east-west component for 10,000-ft layers between 50,000 and 110,000 ft for 36 stations over North America to determine the features of the reversal and (2) the fraction of the daily mean vector blowing from the east or west to determine the relative strength of the easterlies. 20 pp. Illus. Presented before the National Conference on Stratospheric Meteorology at Minneapolis, Minnesota, August 31–September 3, 1959.

- P-1728. The existence of conservation laws—II.** H. A. Osborn. 6-17-59. Unclassified. An application of purely algebraic methods to obtain existence and uniqueness theorems for the conservation laws of an endomorphism of the Pfaffian forms in a neighborhood of a point on a C^∞ manifold, without appeal to the Cartan-Kähler theorem. 28 pp. Presented before the Mathematics Department of the University of Illinois at Urbana, Illinois, January 19, 1961.

- P-1729. A review of binary boundary layer characteristics.** J. F. Gross, J. P. Hartnett, D. J. Masson, and C. Gazley, Jr. 6-18-59. Unclassified.

An examination of several theoretical analyses of laminar and turbulent binary boundary layers. A generalization of the different theories leads to simplified expressions for the heat transfer and friction in both laminar and turbulent binary boundary layers. The results indicate that the effects of different foreign materials are primarily dependent on their relative molecular weights. 96 pp. Illus. Also published as RM-2516. Published in the *International Journal of Heat and Mass Transfer*, October 1961.

- P-1730. Effect of molecular weight on mass-transfer cooling in a laminar boundary layer on a flat plate.** J. F. Gross, J. P. Hartnett, C. Gazley, Jr., and D. J. Masson. 6-18-59. Unclassified.

A discussion of a generalized presentation using available solutions of the laminar boundary layer equations for flow over a flat plate. Heat transfer results for several coolant gases may be presented as a function of mass-injection in such a form that a single curve results, which is valid for the range of Mach numbers and wall-to-free stream temperatures investigated to date. A similar representation is used for the local skin friction coefficient and the recovery factor. Certain relationships pertinent to the application of these results are included. 11 pp. Illus. Published in the *International Journal of Heat and Mass Transfer*, October 1961. Presented before the High-speed Aerodynamics Symposium at San Diego, California, March 27, 1958.

- P-1732. Mass-transfer cooling in a turbulent boundary layer.** J. P. Hartnett, D. J. Masson, J. F. Gross, and C. Gazley, Jr. 6-18-59. Unclassified.

A comparison of experimental results derived from analyses of turbulent binary boundary layer flow—among them, analyses of Dorrance and Dore, Rubesin, and van Driest. The factors considered are heat transfer, skin friction, the effect of pressure gradient, recovery, the addition of foreign gases, mixing length, and the influence of molecular weight. 14 pp. Illus. Published in the *Journal of the Aerospace Sciences*, June 1960. Presented before the Institute of Aeronautical Sciences at Los Angeles, California, June 28–July 1, 1960.

- P-1734. The simulation of human thought.** A. Newell and H. A. Simon. 6-22-59. Unclassified.

A paper that describes a method of studying human problem solving, gives an example of the application of the method, and indicates the theory of problem solving that emerges. The method consists in constructing a theory of central processes in the form of a program, showing the sufficiency of the theory to produce problem-solving behavior by realizing it in a computer, and testing the theory against human processes by comparing the trace generated by the program with the protocol of a human subject. The application consists in a general problem-solving program, capable of solving problems in logic and other domains. The theory of human problem solving consists

in a program for reasoning in terms of goals and methods for attaining those goals and constitutes a rigorous, detailed explanation of a significant area of human symbolic behavior. 43 pp. Illus. Also published as RM-2506. Presented before a group on Current Trends in Psychology at the University of Pittsburgh, Pittsburgh, Pennsylvania, March 12-13, 1959, and published in the proceedings of the Meeting.

P-1735. Spectral measurements of atmospheric radiation from a meteorological satellite. S. M. Greenfield and W. W. Kellogg. 6-23-59. Unclassified.

Sample calculations of emission by water vapor in three wavelength intervals (at two places in the strong absorption band, 6.0 and 6.2 μ , and in the region of weak absorption, 8 to 13 μ). It is shown that the radiation would vary significantly between a tropical air mass and a middle-latitude air mass. Humidities are based on both U.S. and U.K. frost-point observations. 24 pp. Illus. Published in the *Journal of Meteorology*, June 1960.

● **P-1737. Tables of true anomaly versus time interval for Keplerian orbits.** D. S. Kirby. 7-23-59. Unclassified.

A study of the relationship between time and position of an object moving in a Keplerian orbit. Tables are constructed (1) of time interval ratio as a function of the true anomaly and eccentricity and (2) of true anomaly as a function of the time interval ratio and eccentricity. 29 pp. Illus.

● **P-1738. Fundamentals of satellite acquisition ephemerides.** D. S. Kirby. 6-26-59. Unclassified.

An application of the methods of matrix algebra to the problem of acquisition of artificial earth satellites for observing and tracking. The acquisition problem is to locate the object, given preliminary orbital data, in contrast to the tracking problem, which is to measure angular position, rate, and time with sufficient accuracy to define the orbit more precisely. A method of successive approximations to obtain a definitive orbit is accomplished by iterating the acquisition phase and the tracking phase. 24 pp. Illus. Presented before an Astronomy Seminar, held at the University of California at Los Angeles, May 29, 1959.

P-1739. Review of Choh-ming Li's *Economic development of Communist China* (Berkeley, 1959). R. H. Moorsteen. 8-6-59. Unclassified.

A review of the book *Economic Development of Communist China* by Professor Li. The study is an economic analysis of the growth of the Chinese economy from 1952 to 1957 and ranges over almost every major aspect of Communist China's economy (namely, agricultural and industrial output, transportation, national product, investment, budget revenues and expenditures, and international trade). Individual topics on which Professor Li's discussion seems questionable are examined, and the need for finer focus and greater penetration is emphasized. However, the reviewer feels that this book is by far the best to appear on the subject and that one of its most valuable aspects is its extensive collection of economic statistics. 7 pp. Published in *The Journal of Asian Studies*, June 1960.

P-1741. Peaceful atomic-energy programs in Soviet bloc nations. A. M. Jonas. 7-1-59. Unclassified.

A study concerned with the peaceful sharing of atomic energy in the last four years by the USSR with certain nations of the Soviet bloc. Progress has varied from country to country according to the degree of economic and political stability, the level of industrialization, and other factors. These nations have remained closely dependent on technical assistance from the USSR although all of them want their own atomic-power stations eventually. Developments to date in East Germany, Czechoslovakia, Poland, Communist China, Hungary, Rumania, and Bulgaria are reviewed. 33 pp. A shortened version of RM-2290. Published in the *Bulletin of the Atomic Scientists*, November, 1959.

P-1742. A variety of intelligent learning in a general problem solver. A. Newell, J. C. Shaw, and H. A. Simon. 7-6-59. Unclassified.

Part of a broader investigation concerned with exploring the possibilities for learning and self-organization in a computer program—namely, in the General Problem Solver I, or GPS. GPS is a program that incorporates heuristic means for solving a substantial range of problems. This paper considers the approach that because GPS has pretensions of solving a wide array of problems, it

may be possible to let GPS be its own learning program, so that the problem of selecting an A-component will be a problem of the form on which GPS can work. 53 pp. Illus. See also P-1584, P-2257, and P-2349. Incorporated in *Self-organizing Systems: Proceedings of an Interdisciplinary Conference of Self-organizing Systems, 1959*, published by Pergamon Press, New York, 1960. \$8.50. Presented before the Interdisciplinary Conference on Self-organizing Systems at Chicago, Illinois, May 5-6, 1959.

P-1743. Competition and complementarity between defense and development: a preliminary approach. Charles Wolf, Jr. 12-1-59. Unclassified.

An examination of the relationship between defense and development. The discussion is formulated in the context of the less-developed countries. To indicate some of the magnitudes involved, defense expenditures are compared to several economic aggregates in a number of the principal underdeveloped countries. A simple model is then described to define more precisely the possible relationship between defense and development. Some implications for empirical research are also suggested. 14 pp. Tables. Published in abstract form in *Econometrica*, July 1960. Presented before the Econometric Society at Washington, D.C., December 29, 1959.

P-1744. Government efficiency and the military "buyer-seller" device. N. V. Breckner. 7-8-59. Unclassified.

An argument that program efficiency in government will depend substantially on the degree of responsibility in using resources that can be injected into operations where there is continuous selection among optional ways of carrying out activities. One such arrangement being developed within government is the "buyer-seller" device, an attempt to impose on a sprawling network of military units the coordination and constraint that a business firm faces in meting out its product to economic units in a market. The "buyer-seller" device is evaluated in terms of the extent to which it parallels the responsibility borne by decisionmakers in a market environment. While the construct may in many cases be a facsimile of form more than substance, the author encourages the experiments for the more modest pricing contributions that ought to be achievable. 35 pp. Tables. Published in *The Journal of Political Economy*, October 1960.

P-1745. Linearized theory of cavity flow in two dimensions. B. R. Parkin. 7-15-59. Unclassified.

A review of the linearized theory of two-dimensional cavity flows, with particular emphasis on the fundamentals of the theory. Several examples concerned with calculating the hydrodynamic characteristics of both lifting and nonlifting fully cavitating bodies are presented. Flows involving non-steady motions of cavitating bodies and flows having multiple boundaries are considered. To indicate the applicability of the linearized theory, numerical results from it are compared with results from corresponding nonlinearized theories or with experiment for a number of different cavity flows. 190 pp. Illus. Presented before the American Towing Tank Conference at the University of California, Berkeley, California, September 1-2, 1959.

P-1746. Some consequences for quantum electrodynamics of an essential singularity at $\alpha = 0$. P. J. Redmond. 7-10-59. Unclassified.

A re-examination of the argument of Gell-Mann and Low concerning the behavior of quantum electrodynamics at small distances. Within the context outlined, much weaker restrictions are found than those indicated in the original paper. If an approximation to the photon propagator is calculated by summing a selected infinite set of contributions to the spectral density function, the resulting expression has an essential singularity at $\alpha = 0$. It is not of the form predicted by Gell-Mann and Low, but it does satisfy the weaker conditions discussed. 10 pp. Published in *Il Nuovo Cimento*, November 1959.

P-1747. Seven fallacies about Central Africa. Stephen Enke. 7-13-59. Unclassified.

A description of several dangerous fallacies concerning Central Africa, from the viewpoint of the European settler. These misconceptions center around Africa as a concept for policy discussion, African "nationalism," the similarity of black and white race relations in Central Africa to the negro problem in the United States, the supposed economic exploitation of native labor, South and Central Africa's "belonging" to the black natives, the legislation of "freedom," and the suitability of "Western" democracy to Central Africa in the mid-twentieth century. Few people recognize that Western "liberals," leading black African politicians, and the Soviets all have the same immediate goal for

Central Africa—namely, to establish within a few years a black African state, which will result in Central Africa's being lost from the Western sphere of influence. 32 pp. Published in the *Central African Examiner*, April 19, 1959.

P-1748. What interdependence for NATO? M. W. Hoag. 7-13-59. Unclassified. A discussion of the desirable strategic division of labor in NATO. The case for a radical division is argued. By concentrating strategic airpower and its defense in America, and foregoing any sweeping renovation of European tactical capabilities for a strike-second nuclear case, economies are sought that will permit the building of a big, primarily nonnuclear, capability in Europe that is backed by some active deterrent strategic capabilities in America. 36 pp. Published in *World Politics*, April 1960, and in *Survival*, May–June 1960.

P-1749. Discussion of methods of fatigue analysis. F. R. Shanley. 7-6-59. Unclassified. A mathematical theory of fatigue from which stress analysis and design methods can be developed. The theory includes the effects of endurance limit, mean stress, combined stresses, stress concentrations, variable amplitude strain or stress, and thermal fatigue. A comparison is made between the prediction of fatigue life and the prevention of fatigue failures. 25 pp. Illus. Presented at a Wright Air Development Center Symposium at Dayton, Ohio, August 11–13, 1959, and published in the proceedings of the Symposium.

- **P-1750. Radar signal density predictions and measurements.** H. A. Myers. 7-14-59. Unclassified.

A presentation of radar signal density measurements over several areas of the United States, together with the correlation of theory and experiment. The results indicate that the average number of pulses per second received from large radar deployments at various signal levels and altitudes can be predicted to within a factor of 2 over a 50-decibel dynamic range. A few ways are discussed in which signal density prediction can be used to reduce interference in future electronic systems. 27 pp. Illus.

P-1751. Computing and education. F. J. Gruenberger. 7-16-59. Unclassified.

A discussion of such aspects of the relation between computers and educators as (1) the role of a computing center on a university campus and (2) some conjectures as to the proper method of training computer programmers. 9 pp. Illus. Published in *Datamation*, January 1962. Presented before the Northwest Computing Association at Seattle, Washington, August 7, 1959.

P-1752. A technique for handling macro instructions. I. D. Greenwald. 7-16-59. Unclassified.

A description of a machine technique for handling the definition and expansion of a simple class of macro instructions. 10 pp. Published in the *Journal of the Association for Computing Machinery*, November 1959.

P-1753. Geomagnetic control of auroral phenomena. E. H. Vestine. 7-20-59. Unclassified.

An analysis of the path of a line of geomagnetic force from leaving the ground in the southern hemisphere up to point of entry in the northern hemisphere. The discussion summarizes results obtained from an application of the Block and Herlofson method for computing field lines, using more recent data and broadening the scale of coverage. Integral invariants of particle motion are used to describe averaged charged-particle motions. 12 pp. Illus. Presented before the Symposium on Physical Processes in the Sun-Earth Environment, Radio Physics Laboratory, Defense Research Board, Ottawa, Canada, July 20–21, 1959, and published in the proceedings of the Symposium.

- **P-1754. The USSR in the technological race.** Hans Heymann, Jr. 7-20-59. Unclassified.

An attempt to explain the rapid rate of Soviet progress in science and technology and to indicate some of its implications for the United States. Soviet science exists in a political and social atmosphere totally different from our own; it serves concrete national objectives alien to us; and its successes cannot be understood purely in terms of the much-publicized superficial gimmicks of central planning, lavish rewards, and ingenious organizational techniques. This Soviet challenge must be faced in the context of our own social setting and our own values. 15 pp. Presented before the National Strategy Conference for Reserve Officers at The National War College, Washington, D.C., July 20, 1959.

P-1755. On the rationalization of certain complex elliptic integrals. H. A. Lang and D. F. Stevens. 7-14-59. Unclassified.

An elementary method for the rationalization of elliptic integrals of the form

$$a \prod (\varphi, \alpha, \kappa) \pm \bar{a} \prod (\varphi, \bar{\alpha}, \kappa),$$

where a , \bar{a} and $\bar{\alpha}$, α are pairs of complex conjugates. 8 pp. See also P-1498, P-1650, P-2054, and P-2215. Published in *Mathematical Tables and Other Aids to Computation*, April 1960.

P-1756. An outsider surveys the place of public-administration research. F. S. Pardee. 7-20-59. Unclassified.

A discourse on research associated with public administration. The study indicates that whatever specific research project is undertaken, developing informed human beings capable of coping with life in the nineteen seventies, eighties, and nineties is the over-all goal. Basic sources of information must be kept up to date. Textbooks must be revised periodically. Bold new ideas must be investigated and re-examined, and organized plans for research must become basic to the method of operation. 9 pp.

P-1757. Probing space: the astronomer's view. A. G. Wilson, 7-21-59. Unclassified.

An examination of the opportunities that space flight will afford astronomers and of the importance of properly planning space exploration. Astronomy's principal concern—the study of light from celestial bodies—may be carried out from satellite and lunar observatories and by means of interplanetary probes. This science will benefit from the exchange of information with new disciplines such as space physics, planetology, and astrobiology. Some tentative principles of exploration are advanced. 6 pp. Presented before the American Astronautical Society at Los Angeles, California, August 4, 1959.

P-1758. A further comment on economics and operations research. C. J. Hitch. 7-22-59. Unclassified.

A defense of the criterion used in the author's article "Economics and Military Operations Research" (P-1250), published in *The Review of Economics and Statistics*, August, 1959. 4 pp.

P-1759. Transient effects in the distribution of carbon-14 in nature. M. S. Plesset and A. L. Latter. 7-7-59. Unclassified.

An extension of the reservoir model for carbon exchange developed by Craig by dividing the atmosphere reservoir into the stratosphere and the troposphere. The exchange-rate constants are determined for this model. The characteristic times, which determine the transient properties of this six-reservoir model, are evaluated. These times range from the mean lifetime for radioactive decay of carbon-14, 8033 years, to 3.2 years. Explicit solutions for the transient response are presented for a carbon-14 excess introduced instantaneously into the stratosphere or the troposphere. These solutions show a relatively slow decay of an atmospheric transient. The effect of a change in the exchange-rate constants between the stratosphere and the troposphere is shown by explicit solutions for three pairs of values of these constants. 34 pp. Illus. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, February 1960.

P-1760. Future possibilities in fibered material. G. A. Hoffman. 7-13-59. Unclassified.

A discussion of fine crystal filaments—"whiskers"—which have exhibited the highest strengths known in materials, approaching the limit of atomic cohesion. This paper investigates possible means of putting such strength to work in the composition of superior structural materials. The use of whiskers appears to be economically attractive because of possible weight reduction and vehicle payload increases. 9 pp. Illus. Presented before the Sixth Sagamore Research Conference at Raquette Lake, New York, August 18–21, 1959.

P-1761. Model of impulsive noise for data transmission. Pierre Mertz. 7-27-59. Unclassified.

A proposal of a simplified model for impulsive noise (a principal source of interference in communications systems), permitting more systematic quantitative expression. Impulse distribution in amplitude involves substituting an empirical hyperbolic for a Gaussian function, and impulse distribution in time is translated into a time distribution of errors. 32 pp. Illus. Published in the *IRE Transactions on Communications Systems*, June 1961.

P-1762. Effects of earthquakes on tunnels. C. M. Duke and D. J. Leeds. 7-28-59. Unclassified.

A summary of available information on earthquake damage to tunnels. The principal sources are descriptions of events in California and Japan. It is concluded that (1) severe tunnel damage appears inevitable when the tunnel is crossed by a fault or by a fault fissure that slips during the earthquake; (2) shaking may cause severe damage to linings and portals and to the surrounding rock in tunnels away from fault breaks and in tunnels in the epicentral region of strong earthquakes, where construction is of marginal quality; (3) tunnels outside the epicentral region, and well-constructed tunnels in this region but away from fault breaks, can be expected to suffer little or no damage in strong earthquakes; and (4) within the usual range of destructive earthquake periods, intensity of shaking below ground is less severe than on the surface. 27 pp. Illus. Incorporated in R-341 (out of print). Also incorporated in *Protective Construction in a Nuclear Age, Proceedings of the Second Protective Construction Symposium*, Vols. I and II, published by The Macmillan Company, New York, 1961. \$25.00. Presented before the RAND Second Protective Construction Symposium at Santa Monica, California, March 24-26, 1959.

P-1764. Survival position location using star sighting. E. H. Sharkey. 8-20-59. Unclassified.

A method of locating one's geographical position by star sighting that can be used by persons having no knowledge of celestial navigation. The construction of the preformed sighting triangle is described. A star chart, computation sheet, and instructions for using the method are also presented. 18 pp. Illus. Published in *Navigation*, Winter edition, 1959-60.

P-1765. Laminated metal-ceramic composite materials. F. R. Shanley and W. J. Knapp. 7-30-59. Unclassified.

A new method of combining brittle and ductile materials by depositing alternate thin layers of the materials to form a laminated composite. This is broken up into small "pseudo-crystals" that are sintered under high temperature and pressure to form a structural part. The random orientation of slip planes is intended to improve ductility while retaining a large part of the favorable high-temperature properties of the brittle component. 16 pp. Illus. Presented before the Sixth Sagamore Research Conference at Raquette Lake, New York, August 18-21, 1959, and published in the proceedings of the Conference.

● **P-1766. What is dynamic programming?** R. E. Bellman. 7-31-59. Unclassified.

A description of the theory of dynamic programming as the study of multistage decision processes. An attempt is made to explain a multistage process that is a natural extension of semigroups of operations and to illustrate this process by means of the familiar difference and differential equations. To indicate the range and versatility of the functional-equation approach to multistage decision processes, the study considers some maximization problems taken from calculus; some trajectory problems of the type that occur in the study of rockets, satellites, and space travel; a typical feedback control problem of the type current in modern electronic engineering; and an interesting class of multistage games, "games of survival." 27 pp. Illus.

● **P-1767. The consistency of quantum field theories.** P. J. Redmond. 8-6-59. Unclassified.

A discussion of the relativistic field theories with vanishing rest masses and a dimensionless coupling constant. It is shown that such theories cannot be both physically satisfactory and mathematically consistent. The significance of the result for more realistic theories is considered. 11 pp.

● **P-1768. Recent efforts toward coordinated economic planning in the Soviet Bloc.** Oleg Hoeffding. 8-7-59. Unclassified.

A review of the ten-year history of the Soviet Bloc's Council of Economic Mutual Aid (CEMA). The paper describes the first two phases of CEMA (1949-53 and 1954-57) as unimpressive and appraises some of the principal features of the new pattern of economic cooperation now shaping up between the USSR and Eastern Europe. In CEMA's third phase, the prospect of Soviet primary products will enable Eastern Europe to start correcting some of the distortions inherited from earlier years, and the adoption of the new schemes of intersatellite cooperation and coordination of production and investment will undoubtedly lead to more efficient resource use. However, a spectacular acceleration of economic growth should not be expected as a result. 24 pp. Presented before the American Political Science Association at Washington, D.C., September 10, 1959.

P-1769. Soviet foreign aid as a problem for U.S. policy. Hans Heymann, Jr. 12-1-59.
Unclassified.

An investigation of some of the problems that Soviet aid poses for the conduct of our own foreign policy. The particular problem areas discussed are (1) our tendency to overlook the profound differences that exist between the Soviet and the U.S. conceptions of the role and objectives of foreign aid, thereby drawing inappropriate conclusions for our own policy posture; (2) our overly apprehensive concern about Soviet "economic domination" and its effect on U.S. aid policy; and (3) our pressing need to develop more attractive answers of our own to those features of Soviet aid that account for much of its distinctive impact, thus rendering it politically innocuous. 23 pp. Published in *World Politics*, July 1960. Presented before the American Political Science Association at Washington, D.C., September 11, 1959.

P-1771. Translation of artificial languages by compiler programs. R. F. Rosin. 9-3-59.
Unclassified.

A discussion of some of the preliminary work done in the area of symbol manipulation. A program was written in GAT (the University of Michigan 650 compiler) to translate FORTRANSIT (IBM-650 compiler) programs into GAT programs. The paper suggests several possible specifications that might be used for future translations of both artificial and natural languages. 15 pp. Illus. Presented before the Association for Computing Machinery at the Massachusetts Institute of Technology, Cambridge, Massachusetts, September 1-3, 1959.

P-1772-RC. The small world. J. D. Williams. 5-28-59. Unclassified.

Part of a broader investigation concerned with the place of mathematics in the changing society, prepared in response to an invitation from the National Council of Teachers of Mathematics. The paper discusses the implications of certain striking features of our times, external and internal to our society, such as the rate of change of technology and population growth. The fact is emphasized that we have a lot of thinking to do and not much time to do it in and that it would be wise to make decisions and choices deliberately while there are real alternatives, rather than by default when there are none. 24 pp. Illus. A revision of P-1579-RC. Published in *The Saturday Evening Post*, August 6, 1960. Also published in the second series of *Adventures of the Mind*, published by Alfred A. Knopf, Inc., New York, 1961. \$6.50.

P-1773. An introduction to war games. M. G. Weiner. 8-17-59. Unclassified.

Chapter 11 of a book entitled, *Les Choix Economiques: Decisions Sequentielles et Simulation*, edited by Pierre Rosenstiehl and Alain Ghouila-Houri, published by Dunod, Paris, 1960. While the book describes various aspects of simulation, this particular chapter presents only some general information on war games. The paper provides a short history of war games and an introduction to the various characteristics, techniques, and types of war games. An illustration of the steps in an umpired war game is included. 42 pp. Illus.

P-1774. The economics of parallel R and D efforts. R. R. Nelson. 8-24-59. Unclassified.

An examination of the logic of the parallel-path approach to the solution of development problems. If there is considerable uncertainty about the best way to achieve a particular objective, and if it is possible to reduce uncertainty substantially in the early stages of a development effort, parallel work on several alternatives may be a very good strategy. It may even be good strategy to develop completely several systems, test them for performance, calculate their production cost, and then let a production contract for the system that has the best combination of performance and (non R and D) cost. If time is important, a good development strategy should reflect this fact both in running more projects in parallel, and by spending at a faster rate on each of the projects undertaken. 29 pp. Tables. Published in *The Review of Economics and Statistics*, November 1961.

P-1775. The effect of delay distortion on data transmission. Pierre Mertz. 8-17-59.
Unclassified.

Results of delay distortion, which effect primarily an increase in the vulnerability of the signal to noise, so that errors can occur from a smaller noise amplitude. Criteria of distortion are phase departure from linearity, or envelope delay departure from constancy, over the utilized frequency band of the medium. Tolerances are given for noise penalties of 1 to 10 decibels. 27 pp. Illus. Published in *Communication and Electronics*, July 1960.

P-1776. National security policy as a field for economics research. C. J. Hitch. 8-19-59. Unclassified.

A review of major national security areas in the nuclear era where economics research can contribute substantially to the solution of national security problems. The areas discussed are the analysis and measurement of economic strength for war; the implications of large defense budgets in time of peace; the size of the defense budget; efficiency in using and managing defense resources; institutional arrangements to promote efficiency; military research and development; military logistics; the economics of military alliance; economic warfare; mobilization; civil (or nonmilitary) defense and recuperation; and disarmament. Problems of access to data in conducting some kinds of national security research are also examined. 30 pp. Published in *World Politics*, April 1960.

P-1777-AEC. Relativistic self-consistent solutions for atoms of large atomic number. Stanley Cohen. 8-21-59. Unclassified.

Relativistic self-consistent solutions, without exchange, for several atoms of large atomic number, obtained by use of a general program for a high-speed computing machine. This program and the self-consistent calculation are described. Eigenvalues are presented for the individual electron subshells of the self-consistent mercury, tungsten, platinum, and uranium atoms, and a comparison of the calculation with previous results for the mercury atom is included. 28 pp. Tables. Published in *The Physical Review*, April 15, 1960.

P-1778. Dynamic programming and feedback control. R. E. Bellman and R. E. Kalaba. 8-24-59. Unclassified.

An application of the functional equation approach of dynamic programming to deterministic, stochastic, and adaptive control processes. The paper assumes that feedback control processes are multistage decision processes and that problems in the calculus of variations are continuous decision problems. Emphasis is on the development of methods well suited for high-speed digital computation. 17 pp. Published in the *Proceedings of the First International Congress of the International Federation of Automatic Control*, Moscow, 1960.

P-1779. What do we mean by "research and development"? David Novick. 8-25-59. Unclassified.

Suggestions as to how to effectively allocate resources to research and development. A real research effort—one basic in its approach—must be undertaken, and it must be directed toward long-range research. The nation must decide on its objectives and policy in order to establish meaningful classifications of research activities and measurements of the factors in their rate of growth and to determine the allocation of national resources being made to these varying and distinctive types of specialized activities. 50 pp. Illus. Published in abridged form in the *Illinois Business Review*, November 1959, and also in *Air Force and Space Digest*, October 1960. Published in the *California Management Review*, Spring 1960. Presented before the Associated University Bureaus of Business and Economic Research at Monticello, Illinois, October 28, 1959.

P-1780. The use of man-machine simulation in the design of control systems. M. A. Geisler. 8-26-59. Unclassified.

A discussion of control systems in the Air Force context. These are man-machine systems intended to assist the control organization in planning and directing the use of its resources so that the objectives of the organization can best be realized. Future control systems demand much of their designers in terms of flexibility, capability, and responsiveness. Such characteristics are essential for designing systems so far in advance of actual time of use. Simulation techniques, using man and machine methods, provide an effective means of helping the designer to develop system specifications for the range of uncertainties that can be identified at this time. They also provide concrete representations for developing the confidence of the consumer in the capability of the proposed system design. 16 pp. Published in *Operations Research*, September–October 1961. Presented before the Operations Research Society of America at Pasadena, California, November 11–13, 1959.

P-1781. On the increase of convergence rates of relaxation procedures for elliptic partial difference equations. M. L. Juncosa and T. W. Mullikin. 10-15-59. Unclassified.

A paper concerned with the rate of convergence of relaxation methods to the solution of elliptic partial differential equations, which is occasionally adversely affected by the relative proximity of

certain points in the grid. It has been proposed that the removal of the unknown functional values at these points by Gaussian elimination may possibly accelerate the convergence. By application of the Frobenius theory of non-negative matrices, it is shown that the rates of convergence of the Jacobi-Richardson and Gauss-Seidel iterations are not decreased and could be increased by this elimination. 17 pp. Illus. Published in the *Journal of the Association for Computing Machinery*, January 1960.

P-1782. Carbon-14 production from nuclear explosions. M. S. Plesset and A. L. Latter. 8-27-59. Unclassified.

A discussion of the increase in the carbon-14 content of the atmosphere as a consequence of nuclear explosions. In order to obtain the redistribution and decay of an excess of carbon-14 introduced into any of the earth's reservoirs, the time behavior of the carbon exchange system is determined not only for a six-reservoir model, but also after an excess of carbon-14 has been instantaneously introduced into either the stratosphere or the troposphere. The results of the summation of all the carbon-14 activity added to the atmosphere thus far are given, and the effect of an instantaneous exchange between the stratosphere and the troposphere is examined. 21 pp. Illus. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, February 1960.

● **P-1783. Systems design for management automation.** J. A. Postley. 8-28-59. Unclassified.

Emphasis on the need for the advance of science and technology in the management of organizations. The dual problems of applying scientific disciplines and automatic techniques to management-type operations require appropriate changes in our techniques for designing the corresponding systems. The capability to design these systems requires the simultaneous consideration of functional interactions and great detail within each function. This requirement imposes a demand for new skills in systems design. Wherever this increased scope is desired, the authority for systems design must be increased accordingly. While functional knowledge remains the essential key to successful systems design, coordination across functions grows in importance with the growth of efforts to use scientific disciplines and automatic techniques in management-type operations. 9 pp.

P-1784-AEC. Radial distribution functions from the Born-Green integral equation. A. A. Broyles. 8-31-59. Unclassified.

Comparisons between solutions to the Born-Green integral equation and radial distribution functions obtained by the Monte Carlo method by Wood and Parker for the Lennard-Jones potential. It is observed that multiplying the particle separation distance in the Born-Green case by a constant factor improves the agreement for loops beyond the first. 12 pp. Illus. Published in *Journal of Chemical Physics*, August 1960.

● **P-1785. Printed circuits, graphs, manifolds.** J. W. T. Youngs. 8-31-59. Unclassified.

A discussion of the problem of printing a circuit on a board. In mathematical terminology, the problem is one of imbedding a graph on an orientable 2-manifold of minimum genus. It is shown that if a graph is minimally imbedded, then each component of the complement of the graph is an open 2-cell, and further that the number of such components is a maximum. Moreover, the converse statement is also true. The power of this characterization theorem is indicated by applying it to several questions on graphs. 31 pp. Illus.

P-1787. The support of future weapons. C. J. Zwick. 9-3-59. Unclassified.

An attempt to forecast the probable future environment in which the logistics system will have to operate and to discuss the actual functions and responsibilities of the logistics system. This paper emphasizes the need to have the logistician play a more comprehensive role in military planning and the need for organizing a logistics system so that it can react to changing information. If these two requirements are not met, most of the potential benefits of new logistics hardware and management concepts will be lost. 11 pp. Presented before the National Security Industrial Association Maintenance Advisory Committee meeting at Denver, Colorado, August 19, 1959.

P-1788. Estimation of Doppler shifts in noise spectra. Peter Swerling. 9-4-59. Unclassified.

A method of analyzing the structure of a frequency spectrum, based on the observation of some portion of a sample function. In application, the method might be used to yield information on the

velocity of a space vehicle. 20 pp. Illus. A revised version of RM-2273. Presented before the Institute of Radio Engineers National Convention at New York City, March 20-23, 1960.

P-1789. Economic consequences of substantial changes in the method of taxing capital gains and losses. W. A. Steger. 9-9-59. Unclassified.

An investigation of the economic effects that would accompany the full inclusion of what are now called capital gains and losses in the income base for federal income tax purposes. The economic effects discussed range from the allocation of scarce resources to the level and stability of national income. The study (1) estimates the amounts of unrealized capital gains and losses and the effects of taxing these at different periods; (2) assesses how the effective rate on capital gains and losses would change if they were included in taxable income in full, with and without averaging; and (3) investigates the effects on tax revenues of various changes in the capital asset sections of the tax law. It is indicated that promoting a high standard of "equity" in the tax law might cause severe economic repercussions. 47 pp. Tables. Published in *Tax Revision Compendium, Compendium of Papers on Broadening the Tax Base, Submitted to the Committee on Ways and Means in Connection with the Panel Discussions on the Same Subject To Be Conducted by the Committee on Ways and Means, Beginning November 16, 1959*, Volume 2.

P-1790-AEC. Electron radiative transitions in a Coulomb field. R. Latter and W. J. Karzas. 9-4-59. Unclassified.

The computation of free-free, bound-free, and bound-bound Gaunt factors and oscillator strengths for electrons in a pure Coulomb potential. Numerical results are presented for a wide range of electron and photon energies. In addition, for the free-free case, average Gaunt factors and the rate of Bremsstrahlung production have been obtained as functions of temperature for a Boltzmann distribution of electron energies. 48 pp. Illus. Published in *The Astrophysical Journal*, Supplement Number 55, May 1961.

P-1791. The use of simulation in logistics policy research. W. W. Haythorn. 9-10-59. Unclassified.

Chapter 13 of a book entitled *Les Choix Economiques: Décisions Sequentielles et Simulation*, edited by Pierre Rosenstiehl and Alain Ghouila-Houri, published by Dunod, Paris, 1960. The book describes various aspects of simulation. This particular chapter discusses two large systems simulation experiments, emphasizing the methodology used. The experiments are those of RAND's Logistics Systems Laboratory: LP-I (an experiment to evaluate a set of proposed supply policies and procedures in a simulated Air Force environment) and LP-II (a study of a ballistic missile system in which supply, manning, equipping and maintenance policies and procedures were meshed with operational requirements and hardware reliability assumptions to yield measures of expected workload, supply requirements, operational effectiveness, and costs). 45 pp. Illus.

P-1792. Widths and heights of $(0, 1)$ -matrices. D. R. Fulkerson and H. J. Ryser. 7-18-60. Unclassified.

A problem which assumes that A is an m by n $(0, 1)$ -matrix and that E^* is an m by ϵ submatrix of A having the property that each row of E^* contains at least α 1's. The ϵ columns of E^* are said to form an α -set of representatives for A . Let $\epsilon(\alpha)$ be the minimal number of columns of A that form an α -set of representatives. The integer $\epsilon(\alpha)$ is called the α -width of A . This paper studies the minimal α -width $\epsilon(\alpha)$, the minimum being taken over the class of all $(0, 1)$ -matrices having specified row and column sums. A canonical form is developed for a matrix of α -width $\epsilon(\alpha)$ that leads to explicit formulas for both $\epsilon(\alpha)$ and $\delta(\alpha)$, the minimal α -height of all matrices $A_{\epsilon(\alpha)}$ in the class. 36 pp. See also P-2272. Published in the *Canadian Journal of Mathematics*, Vol. XIII, No. 2, 1961.

P-1793. A new book on East German trade. Horst Mendershausen. 9-11-59. Unclassified.

A review of Erich Klinkmüller's new book on the foreign-trade system of Soviet-occupied Germany. The book offers a statistical study of East German foreign economic relations, particularly with the Soviet Union and the Soviet Bloc. It discusses various theoretical and institutional aspects of these relations, such as the problems of foreign trade planning, the dichotomy of internal and foreign trade prices, the dominant role of the Soviet Union in East German economic policy, bilateralism, and economic coordination within the Bloc. This monograph is one of the best studies

of the East German economy, and it is hoped that it will encourage further work on the fundamental relations in that economy. 5 pp. Published in *The American Economic Review*, March 1960.

P-1794. Induced oscillations in a rarefied plasma in a magnetic field. P. H. Greifinger. 7-1-60. Unclassified.

An investigation of the energy loss due to excitation of collective motion of plasma for a charged object traveling through a low-density, unbounded, fully ionized plasma in an external, uniform, static magnetic field B_0 for the case of $V_0^2 \ll \langle V^2 \rangle$ and $T_+ \rightarrow 0$. 15 pp. Also published as Chapter 19 of R-339. Published in *The Physics of Fluids*, January 1961.

P-1795. The geomagnetic field in space, ring currents, and auroral isochasms. E. H. Vestine and W. L. Sibley. 9-14-59. Unclassified.

An examination of the geomagnetic interlinkage between northern and southern auroral zones. Descriptions are given of probable relationships among geomagnetic field lines, the auroral zones, and the supposed equatorial ring current. A mechanism is outlined that may show the relationships of auroral phenomena to the mirror points reflecting particles from pole to pole, to energy variations in the Van Allen radiation belt, and to polar electric currents. 33 pp. Illus. Published in *Journal of Geophysical Research*, July 1960.

• **P-1796. The normative interest rate.** E. B. Berman. 9-15-59. Unclassified.

An investigation of the normative interest rate, defined as the discount rate the government ought to use in making its investment decisions. Various alternatives of setting the level of the normative interest rate are examined. The return on marginal private investment, national time preference, and the long-term interest rate at which the government can borrow are rejected on the basis that they are merely adaptive to the nation's interest-rate structure, which is decided in turn by the government. The appropriate normative interest rate is then determined as a rate that is consistent with itself through the rate of growth of national product and the rate of decline in the marginal utility of national product. 39 pp. Illus.

P-1797. Transport theory and invariant imbedding. R. E. Bellman and R. E. Kalaba. 12-7-59. Unclassified.

An indication of some of the applications of the theory of invariant imbedding that have been made to the field of neutron transport theory. Invariant imbedding is discussed, and several versions of a one-dimensional neutron multiplication process are treated. The paper emphasizes the feasibility of determining criticality conditions without the solution of eigenvalue problems and of determining reflected and transmitted flux. 27 pp. Published in the *Proceedings of Symposia in Applied Mathematics—Vol. XI: Nuclear Reactor Theory*, American Mathematical Society, Providence, Rhode Island, 1961. \$8.70.

P-1798. Some optimization problems in chemical engineering. R. Aris, R. E. Bellman, and R. E. Kalaba. 9-17-59. Unclassified.

A study of several optimization problems associated with the multistage compression of a gas. Multistage processes occurring in the modern chemical plant are designed to convert the state of the entering process stream into a potentially more valuable one. In order to accomplish this with the maximum profit, a policy is sought for controlling the operating variables. The values of these variables that maximize the profit function for a given state of the input stream are said to form an optimum policy in connection with that input. It is found that the application of the dynamic-programming principle to the various problems yields a functional equation for the maximum profit function. 32 pp. Published in the *Chemical Engineering Symposium Series*, 1960.

P-1799. Summary of a heuristic line balancing procedure. F. M. Tonge. 9-18-59. Unclassified.

An attempt to investigate the application of complex information-processing techniques (as used in producing the Chess Machine and Logic Theorist) to a typical industrial problem. The following assembly-line balancing problem is presented: Given an assembly process composed of elemental tasks, each with a time required per unit of product and an ordering with other tasks, what is the least number of work stations needed to attain a desired production rate? The paper discusses a heuristic procedure for balancing production assembly lines and a computer program for implementing the procedure. 47 pp. Illus. Published in *Management Science*, October 1960.

- **P-1801. A scientist's notes on the cold war.** A. G. Wilson. 9-18-59. Unclassified.
A commentary, drawn from first-hand observations, on the pattern of Soviet efforts to woo public opinion among the people of Asia. The paper includes political sidelights of observations collected while traveling in Soviet Europe and Asia as a delegate to the 1958 International Astronomical Union conference held in Moscow. 26 pp. Presented before the School of Aviation Medicine at San Antonio, Texas, November 27, 1958.

P-1802. Directions of mathematical research in nonlinear circuit theory. R. E. Bellman. 9-23-59. Unclassified.

A discourse on the future directions of mathematical research in the field of nonlinear circuit theory. Admitting that it is brash to predict mathematical requirements even 10 years from now in our rapidly changing technology, the author discusses descriptive, control, stochastic, and many other types of problems arising in nonlinear circuit analysis. The difficulties prevalent render a certain time lag inevitable, and it may well be that new scientific developments may render fields obsolete and mathematical solutions for problems within those fields unnecessary even before they are obtained. 46 pp. Published in the *IRE Transactions of the Professional Group on Circuit Theory*, December 1960.

P-1803. The federal budget as an indicator of government intentions and the implications of intentions. David Novick. 10-1-59. Unclassified.

An examination of the present budget structure from the standpoint of how well it indicates government intentions and the implications of intentions. It is shown that this purpose of the budget is essentially synonymous with that aspect of budgeting associated with making major resource allocation decisions. In such a context, the present budget structure is found deficient in several major respects. These deficiencies provide the basis for suggestions on how the present budget format may be improved. 24 pp. Illus. Published in the *Harvard Business Review*, May-June 1960. Presented before the American Statistical Association at Washington, D.C., December 28, 1959.

P-1804. Dynamic programming and classical analysis. R. E. Bellman. 9-28-59. Unclassified.

A consideration of questions in analysis that arise naturally out of the functional-equation technique of dynamic programming. It is shown that this theory constitutes a natural extension of classical investigations and that the corresponding problems are natural generalizations of problems of classical analysis. Emphasis is on deterministic processes. 22 pp. Published in the *Boletín de la Sociedad Matemática Mexicana*, 1960.

- **P-1805. The failure of the universities—I: scientific and technological.** R. E. Bellman. 9-28-59. Unclassified.

A discussion of the lack of universality of the university, of the artificial images of the "intellectual man" and the "practical man," and generally, of life, liberty, and the pursuit of knowledge. 31 pp.

- **P-1806-1. Parameter-free and nonparametric tolerance limits: the exponential case.** L. A. Goodman and A. Madansky. 8-1-61. Unclassified.

The development of exact parameter-free tolerance intervals based on the first r -ordered observations from a sample of size n from an exponential distribution. The authors examine various criteria for goodness of tolerance intervals, as well as the asymptotic behavior and certain optimum properties of these intervals. Comparisons are made between these intervals and the nonparametric tolerance intervals. The paper also discusses the effect of assuming an exponential distribution, when in fact the distribution is a mixture of two exponentials. 39 pp. Tables.

- **P-1807. Tables of the binomial probability distribution $b(r; N, p)$ for large N and small p .** D. S. Hopp and M. Warshaw. 8-13-59. Unclassified.

The title of this paper describes its contents. 90 pp. Tables.

P-1808. Simulation techniques. M. A. Geisler. 9-4-59. Unclassified.

A talk presented before the International Air Transport Association at Paris, France, September 4, 1959, which discusses how the Air Force is attempting to substitute better management for larger resource expenditures. Simulation is shown as a powerful planning tool. Its design, construction, and use requires the application of many skills. Some of the complex requirements of this work are a knowledge of the real-world environment, mathematical training to design simulation models,

accounting people and others to provide data for the model, computing people to program and compute with the models, and analysts to interpret the results and control the experiment. 9 pp. Presented before the International Air Transportation Association at Paris, France, September 4, 1959.

P-1809. Some aspects of adaptive control processes. R. E. Kalaba. 9-29-59. Unclassified.

A study of adaptive control processes that shows how the functional-equation technique of dynamic programming can be used in their analytical and computational treatment. Several adaptive control processes pertaining to a system governed by an inhomogeneous Van der Pol equation are discussed, one of which involves optimal control of the system with an objective that is only partially known to the controller. 18 pp. Published in the *Boletín de la Sociedad Matemática Mexicana*, 1960. Presented before the International Symposium on Differential Equations at Mexico City, September 7-12, 1959.

● **P-1810. Measuring missile reliability in pre-launch environments.** D. S. Stoller. 5-9-60. Unclassified.

An examination of some of the problems involved in measuring missile reliability during its pre-launch phase. Reliability is defined as the probability that an aggregate will successfully perform a specified task in a specified environment over a specified period of time. Several of the most important prelaunch operating environments are: turn-on (-off), checkouts, countdowns, operating alert, standby alert, handling, transportation, periodic maintenance, and storage. The use of a missile status log is discussed in terms of measurement of missile-weapon-system reliability. A reliability measurement policy is suggested, and several difficulties of a reliability measurement system are noted. 21 pp. Illus. An extension of P-1672. Presented before the Sixth Joint Military-Industry Guided Missile Reliability Symposium at Fort Bliss, El Paso, Texas, February 15-18, 1960.

P-1811. A mathematical model of the human external respiratory system. G. B. Dantzig, J. C. DeHaven, I. Cooper, S. M. Johnson, E. C. DeLand, H. E. Kanter, and C. F. Sams, M.D. 9-28-59. Unclassified.

The results of a mathematical simulation of the external respiratory function to illustrate the thesis that important subsystems of the human body can be studied by mathematical programming techniques that have been used to program and control complex military and industrial systems. The model constructed shows the process occurring when air is breathed and mixed with venous blood in the lungs, which results in exhaled air and arterial blood. From the long-range viewpoint, such simulation may provide a powerful new tool for biological investigations. 101 pp. Illus. Also published as RM-2519. See also P-2048 and P-2139. Published in the *Perspectives in Biology and Medicine*, Spring 1961.

P-1812. On a phase method for treating Sturm-Liouville equations and problems. Nelson Wax. 10-5-59. Unclassified.

A treatment of a Sturm-Liouville equation by transformation to a phase equation. The iterative approximations to the solution of the phase equation are used to approximate the eigenvalues of the Sturm-Liouville problem for general boundary conditions. 23 pp. Tables. Published in the *Journal of the Society for Industrial and Applied Mathematics*, June 1961.

● **P-1813. The upper atmosphere as observed with rockets and satellites.** W. W. Kellogg. 1-11-60. Unclassified.

A review of advances in the understanding of the upper atmosphere that have occurred during and since the I.G.Y., with emphasis on recent observations with rockets and satellites. The global coverage of these upper-atmosphere observations has revealed important latitudinal and seasonal changes in densities, pressures, and winds. The composition of the upper atmosphere, and its electrical properties, have been observed, and the influxes of energetic particles and radiations from the sun and the radiation belts have been studied from above the atmosphere. 11 pp. See also P-1876. Presented before the School of Aviation Medicine at Brooks Air Force Base, Texas, January 11, 1960.

P-1815. Continuous programming methods on an analog computer. E. C. DeLand. 9-29-59. Unclassified.

A feasible solution of a programming problem, in which a positive vector x maximizes a function $g(x)$ under m convex conditions $f_i(x) \leq 0$, which usually exhibits certain stable properties. The

entire system can be said to be in equilibrium or it can be considered an equilibrium model. Beginning at a solution, a time transient may be induced in the system by making f and/or g functions of time. Methods for examining such transients on the analog computer are examined and examples are given. The problem considered arises because the behavior of a system in time and under the influence of a variation of parameters is often as interesting as its behavior in the initial or final stable states. Typical examples are found in a petroleum fractionating column or in a complex chemical equilibrium. 11 pp. See R-351. Presented before the Symposium on Mathematical Programming at Santa Monica, California, March 16-20, 1959.

P-1816. Polar auroral, geomagnetic, and ionospheric disturbances. E. H. Vestine. 10-7-59. Unclassified.

The cause of arctic polar electrojets associated with radio blackouts, auroras, and magnetic storms, explained on the basis of penetration of charged particles from solar streams. The stretching of geomagnetic field lines high above the polar caps results in deeper penetration of particles into the low ionosphere in two regions, causing electrojets. This deeper penetration is required to conserve an integral invariant of charged-particle motion in the geomagnetic field. The same mechanism explains the increased frequency of auroras near midnight. 6 pp. Published in the *Journal of Geophysical Research*, January 1960.

P-1817. An information processing theory of verbal learning. E. A. Feigenbaum. 10-9-59. Unclassified.

A theory of some elementary forms of human symbolic learning: memorization, discrimination, association, and attention direction. The theory is concerned with mental activity at the level of the processing of information symbols, which are the basic units manipulated. The precise statement of the theory is given in the language of a digital computer, specifically as a set of programs in IPL-V (Information Processing Language), called EPAM (Elementary Perceiver and Memorizer). The paper deals generally with information structures and processes for discrimination and association learning, and specifically with behavior in the standard rote-learning task. A number of implications of the theory in rote-learning situations are explored, and comparisons are drawn between the behavior of human subjects in these situations and the behavior of the EPAM model. 169 pp. Illus. A slightly altered version of the author's Ph.D. thesis at Carnegie Institute of Technology.

P-1820. An experiment in chess playing by machine. F. J. Gruenberger. 10-13-59. Unclassified.

A paper consisting of a long expository letter published in the January 15, 1960, issue of *Computing News* concerning RAND's activities in chess playing. 11 pp. Illus.

P-1821. Predictability of the costs, time, and success of development. A. W. Marshall and W. H. Meckling. 12-11-59. Unclassified.

Results of some recent research into the extent and nature of the uncertainty in new developments, with emphasis on problems of development in the Air Force. "Early" estimates of important parameters are usually quite inaccurate because they are "biased" toward overoptimism and because the errors in estimates evidence a substantial variation. The accuracy of estimates is found to be a function of the stage of development, i.e., estimates improve as development of the item progresses. 24 pp. Tables. Presented before the Conference on the Economic and Social Factors Determining the Rate and Direction of Inventive Activity, held at the University of Minnesota, Minneapolis, Minnesota, May 12-14, 1960.

● **P-1822. Some special search problems.** O. A. Gross. 10-20-59. Unclassified.

An illustration of various categories and aspects of search problems by a discussion of particular typical problems solved at RAND. A search problem is broadly defined as a puzzle requiring for its solution an efficient technique or algorithm for locating or gaining desirable information about some object. The object may be physical or perhaps purely mathematical in character. 18 pp. Presented before the IRE Professional Group on Information Theory at Los Angeles, California, October 12, 1959.

P-1823. The use of man-machine simulation for support planning. M. A. Geisler. 10-20-59. Unclassified.

A talk presented before the Decennial Logistics Conference at Washington, D.C., January 20, 22, 1960. The conditions under which support planning must be performed in the present and future

military environment are discussed, and the experience of LP-II in performing such planning for an ICBM weapon of the 1963-1965 time period is described. From this experiment much knowledge has been gained about support concepts and policies, management systems, and simulation techniques. These findings may be applied to the design of man-machine control systems, organizational and information research, and decision theory. 17 pp. Published in the *Naval Research Logistics Quarterly*, December 1960.

- **P-1824. The mutual attraction of cloud droplets in the electrostatic field of the atmosphere.** J. D. Sartor. 10-21-59. Unclassified.

A discussion of the coalescence of cloud droplets that is necessary for the formulation of rain at temperatures above freezing. Upon colliding, larger water drops are commonly observed to rebound without coalescing unless electrostatic fields are present. This paper uses a theoretical solution by Dr. M. H. Davis to the force and field between two equal conducting spheres in a uniform field to compute the forces and fields between neighboring cloud droplets. The results explain the observed electrostatic coalescence. 20 pp. Illus. One of a series of lectures presented before a Cloud Physics Seminar at the University of California at Los Angeles, October 17-28, 1960.

- **P-1825. An out-of-kilter method for minimal cost flow problems.** D. R. Fulkerson. 4-5-60. Unclassified.

A method of solving minimal-cost network flow problems. This method begins with any circulation, feasible or not, and an arbitrary pricing vector. A labeling procedure is then used to adjust out-of-kilter arcs, that is, arcs that fail to satisfy the optimality properties. It is shown that the method terminates in a finite number of steps, and that in so doing, the status of no arc of the network (as measured by certain "kilter numbers") is worsened at any step. 22 pp. Illus. Published in the *Journal of the Society for Industrial and Applied Mathematics*, March 1961.

- **P-1826. A structural approach to military air transportation.** W. A. Niskanen and R. B. Rainey. 10-23-59. Unclassified.

A discussion of the use of various operations-research techniques to help resolve several issues important in building an effective military air transport system within the next decade. An attempt is made to determine the nature and magnitude of the major military airlift missions and the best combination of aircraft and trained personnel to perform these missions. The approach used considers the strong trade-off between flying hours and fleet composition, evaluates the potential contribution of the commercial fleet in the context of planning for the military fleet, and separates mission requirements into discrete periods to permit evaluation of the imputed cost of airlift in different periods. 14 pp. Presented before the Operations Research Society of America at Pasadena, California, November 11, 1959.

- **P-1827. On one-dimensional inviscid magnetohydrodynamic flow.** J. D. Cole and J. H. Huth. 12-28-59. Unclassified.

A paper on the one-dimensional steady flow of a compressible inviscid conducting gas through a transverse magnetic field that is characterized by a single nondimensional plot, independent of conductivity. The coordinates are the magnetic-field strength and the fluid-flow velocity. Parameters that characterize events are the entrance Mach number, the constant electric field, and the ratio of magnetic-energy density to initial-flow kinetic-energy density. 18 pp. Illus.

- **P-1828. Peak loads and efficient pricing: a general solution and a practical approach.** C. B. McGuire. 10-28-59. Unclassified.

A commentary on the recent discussions in the *Quarterly Journal of Economics* on the problem of peak loads and efficient pricing, as well as on the "rediscovered" paper of Boiteux. Two shortcomings are indicated in that the "marginal conditions" characterizing the solution to the problem are not presented at the level of generality traditionally demanded and that the "practical" formulas proposed are not sufficiently practical. This paper describes what the author believes to be the correct general solution to the problem and proposes an easy algorithm for finding explicit answers in a certain class of special cases. 9 pp.

- **P-1829. Dynamic similarity and the modeling of cloud droplets.** J. D. Sartor. 10-30-59. Unclassified.

An investigation of the requirements for the laboratory modeling of the motion of cloud droplets, using the principles of dynamic similarity and the concepts of induced mass and hydrostatic buoyancy.

It is concluded that cloud droplets can be successfully modeled in the laboratory as long as the Reynolds number is small with respect to 18 and that the results can be compared with Hockings theoretical results when the Reynolds number is less than one. 6 pp. Presented before the American Meteorological Society at Chicago, Illinois, March 21, 1961.

- **P-1830. Drag coefficients of small, irregular particles.** J. D. Sartor and R. R. Rapp. 10-30-59. Unclassified.

Results of several laboratory tests conducted with spherical and irregularly shaped particles. These measurements were made to clarify the law of fall of irregular particles in the range of Reynolds numbers from 0.035 to 3.5. The results of the experiments are presented in tabular form, and are compared graphically with the theoretical approximation to the rate of fall of spheres and with the accepted curve for spheres. 15 pp. Illus. Also published as RM-2006.

- **P-1831. The rational points on a transcendental curve.** O. A. Gross. 11-2-59. Unclassified.

A presentation of a short elementary proof of the irrationality of $\tan^{-1}\rho/\pi$, where ρ is a positive rational number different from unity. 7 pp.

- P-1833. The simple mathematics of maximization.** A. C. Enthoven. 11-3-59. Unclassified.

An economic approach to the problem of military choice (namely, that of allocating a fixed budget among alternative strategic weapon systems, or of finding the maximum of some relevant measure of strategic airpower, given the limitation of a fixed budget). The complexity of military choice is discussed in terms of criterion selection, values, and intangibles, and in terms of risk and uncertainty about nature, technology, and enemy reactions. As no simple formal model of choice is sufficient for a satisfactory analysis of most real military problems, this paper formulates parts of the problems of choice in economic terms, that is, in terms of discovering the most effective uses of limited resources. 70 pp. Illus. Included as an appendix in R-346 (out of print). Incorporated in *The Economics of Defense in the Nuclear Age*, published by Harvard University Press, Cambridge, Massachusetts, 1960. \$9.50.

- P-1834. Manned control of orbital rendezvous.** Eugene Levin and J. W. Ward. 10-20-59. Unclassified.

A device assembled at RAND to simulate the in-plane response of an orbiting space vehicle to applied thrusts. This simulator was used to study manned control of an orbital rendezvous maneuver. It was found that a pilot with appropriate display and controls could direct the extreme terminal portion of the rendezvous maneuver with great precision and flexibility. 16 pp. Illus. Published in *Aerospace Engineering*, May 1960. Presented before the National Symposium on Manned Space Stations at Los Angeles, California, April 20-22, 1960.

- P-1835. Invariant imbedding and neutron transport theory—V: diffusion as a limit-case.** R. E. Bellman, R. E. Kalaba, and G. M. Wing. 11-9-59. Unclassified.

A study of the limits of the nonlinear functional equations obtained from the transport processes with finite velocity as the velocity increases without bound. Corresponding results are determined for heat or diffusion processes where the physical picture is not so clear. The equations, having been obtained in an indirect and complex fashion, can then be interpreted in such a way as to derive them directly by invariant imbedding techniques. In all cases, the equations are of the generalized Riccati type, which are characteristic of these processes of mathematical physics. 23 pp. Published in *Journal of Mathematics and Mechanics*, November 1960.

- P-1837-1. Guide to Russian reference and language aids: an annotated bibliography.** R. L. Neiswender. January 1962. Unclassified.

A bibliography of current Russian reference and linguistic materials. The bibliography is limited to the areas of science and technology and, as far as possible, to publications issued since World War II and still in print. Appendices to the bibliography include a description of Russian transliteration systems, a selective listing of U.S. and foreign dealers in Russian books and periodicals, a list of abbreviations of Soviet publishing houses, and an author-title index to the citations. 82 pp.

- **P-1839. Ballistic-missile payload allocation.** S. I. Firstman. 11-12-59. Unclassified.

A method for determining for a ballistic missile the optimum division of weight allocation to warhead, guidance, and penetration aids when the weight-effectiveness relationships of the individual elements are known for an attack against a defended point target. The use of this method shows the influence of the estimate uncertainties on the optimal payload division and may be helpful in design compromise procedures. 22 pp. Illus.

- P-1840. The contextual study: a structured approach to the study of political and military aspects of limited war.** J. W. Ellis, Jr., and T. E. Greene. 5-10-60. Unclassified.

A description of a structured analytical method of study in which it is possible to consider simultaneously the military and political factors of a limited war. Applications to other types of problems are suggested that involve close interaction among quantifiable and non-quantifiable factors. 20 pp. Published in *Operations Research*, September–October 1960. Presented before the Operations Research Society of America at Pasadena, California, November 11, 1959.

- P-1841. Vehicles for exploration on Mars.** T. F. Cartaino. 10-29-59. Unclassified.

An examination of vehicles that might be used by manned expeditions to explore Mars after landing. The feasibility of designing such vehicles, and some propulsion systems that might be used, are considered. 18 pp. Illus. Presented before the American Rocket Society Space Vehicles Conference at Santa Barbara, California, April 6–8, 1960, and published in the proceedings of the Conference.

- **P-1842. Linear programming in a Markov chain.** P. S. Wolfe and G. B. Dantzig. 11-23-59. Unclassified.

A study of an infinite Markov process with a finite number of states in which the transition probabilities for each state range independently over sets which are either finite or are convex polyhedra. A finite computational procedure is given for choosing those transition probabilities which minimize appropriate functions of the resulting equilibrium probabilities. 19 pp. Table. Superseded by RM-2957-PR. Presented before the American Mathematical Society at New York, New York, April 14–16, 1960, and before the Econometric Society at Palo Alto, California, August 23–26, 1960.

- **P-1843. Functional equations in the theory of dynamic programming—XI: limit theorems.** R. E. Bellman. 11-30-59. Unclassified.

A presentation of a limit theorem valid for a general class of Markovian decision processes. The result is of interest because of the simple conditions imposed and the rather simple argument used. 7 pp. Published in *Rendiconti del Circolo Matematico di Palermo*, Series II, Vol. VIII, 1959.

- P-1844. Infrared detection by ideal irasers and narrow band counters.** R. W. Gelinas. 10-26-59. Unclassified.

A comparison of the performance of two proposed infrared detectors—the infrared maser ("iraser") and the quantum counter—with that of conventional, broadband photoconductors and thermal detectors. While the successful development of irasers or of narrow-band quantum counters may constitute an important breakthrough in detector technology, this paper shows that conventional detectors are uniformly superior for the most important application of infrared, that of detection where the target is either gray body radiation or the relatively broadband spectral radiation from excited gases. 36 pp. Illus. Presented before the Infrared Information Symposium, sponsored by the Office of Naval Research, at Pasadena, California, November 17–19, 1959, and published in the proceedings of the Symposium.

- P-1845. The upper atmosphere and geomagnetism.** E. H. Vestine. 12-3-59. Unclassified.

An examination of transient geomagnetic changes related to solar and lunar events, as well as to a number of phenomena of the upper atmosphere. The variation is believed to be caused by electric-current systems arising from fluctuating ionospheric winds, which blow the ionized air across the lines of force of the geomagnetic field. 67 pp. Illus. Published as Chapter 7 in *Physics of the Upper Atmosphere* by Academic Press, New York, 1960. \$14.50.

P-1846. On the separation of exponentials. R. E. Bellman. 12-11-59. Unclassified.
A problem concerned with the sequence $\{u_n\}$, which has the representation $u_n = \sum_{k=1}^N c_k \exp \lambda_k n$. A method designed to yield the value of N without determining c_k and λ_k is outlined. 4 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 15, No. 3, 1960.

- **P-1847. Quasi-concave programming.** K. J. Arrow and A. C. Enthoven. 12-16-59. Unclassified.

A fundamental problem dealing with the maximization of a differentiable quasi-concave function, $f(x)$, or an n -dimensional vector x , subject to the constraints $g(x) \geq 0$, where $g(x)$ is a differentiable quasi-concave vector function, and $x \geq 0$. The paper contains four theorems. The first theorem extends the Kuhn-Tucker-Lagrange sufficiency conditions to quasi-concave $f(x)$ and $g(x)$ by adding some supplementary conditions. The second theorem presents a version of the Kuhn-Tucker *Constraint Qualification* applicable to quasi-concave functions. The third theorem relates the concepts of quasi-concavity and diminishing marginal rates of substitution. The fourth theorem relates quasi-concavity to the familiar bordered determinant second-order condition for a constrained maximum. Also included are extensions of Theorems 1 and 2 to other problems (dropping the non-negativity constraints, equality constraints, and unconstrained maxima) and economic applications (consumer demand, production theory, and welfare economics). 41 pp.

P-1848. An index of Soviet industrial output. N. M. Kaplan and R. H. Moorsteen. 3-2-60. Unclassified.

The results of a calculation of an index of Soviet industrial output, and some comments on, and application of, these results. Part I presents the index of Soviet industrial output and discusses its nature and limitations. Part II considers the index of industrial output in comparison with others, some dynamic aspects of Soviet industrial growth, indicated future rates of growth, an index of the output of final products, and estimated changes in productivity. 44 pp. Tables. See also RM-2495. Published in *The American Economic Review*, June 1960.

P-1849. Some military applications of the theory of games. Melvin Dresher. 12-10-59. Unclassified.

An application of the theory of games to military problems concerned with the allocation of forces in space and/or time in a competitive environment. The examples are from the general military fields (1) of strategic air war in which an important problem is that of target selection, (2) of tactical air war in which the game is viewed as consisting of a series of strikes or moves, and (3) of target prediction in which the problem of scheduling the launching of missiles is described. 15 pp. Presented before the 5th SHAPE Operations Research/Scientific Advisory Conference at Paris, France, May 18-20, 1960. Also presented before the Second International Conference on Operational Research at Aix-en-Provence, France, September 5-9, 1960, and published in the proceedings of the Conference.

- **P-1850. Is deterrence enough or should we be prepared to fight a general war in the 1960's?** E. J. Barlow. 12-11-59. Unclassified.

An attempt to determine (1) whether the deterrent offered by the secure strike-second retaliatory force is an adequate general-war posture, (2) whether the possibility should be conceded that the United States might have to experience a general war in the next decade and to trace through the requirements for damage limitation and military termination, and (3) how important is the threat of general war short of an assault directly on the United States. Some of the difficulties inherent in planning a national strategy are indicated, as well as some of the issues involved (problems of genetics, physical bomb damage, military tactics, and political and psychological attitudes). 19 pp. Presented before the Economic Club of Detroit, Detroit, Michigan, January 18, 1960.

P-1851. Inductive proof of the simplex method. G. B. Dantzig. 5-9-60. Unclassified.

A proof of the existence of an optimal basis in the simplex method based on induction. Specifically, it is shown that a finite chain of feasible basis changes exists, resulting in either an optimal feasible solution or in an infinite class of feasible solutions, such that the objective form tends to minus infinity. 9 pp. Published in the *IBM Journal of Research and Development*, November 1960.

P-1852. Multiple regression analysis of a Poisson process. D. W. Jorgenson. 10-31-60. Unclassified.

A discussion of some areas of application for multiple regression analysis of a Poisson process by estimating the relative stress of operating regimes and by predicting failures given elapsed time under several regimes of stress. This paper examines maximum likelihood, least squares, and weighted least-squares estimators for parameters of a Poisson process characterized by more than one operating environment. The author examines known results on simple regression analysis of a Poisson process, estimators and computational methods for multiple regression, large sample properties of these estimators, and a numerical example illustrating the application of each of the estimators to failure data. Elapsed time is also reinterpreted to take into account "on-off" and "burn-in" stress. 18 pp. Tables. Published in the *Journal of the American Statistical Association*, June 1961.

P-1853. The use of reliability estimates in the design of missile prelaunch checkout equipment. S. I. Firstman. 1-5-60. Unclassified.

A discussion of the problem of using reliability estimates to determine which individual checks to include in a missile prelaunch confidence checkout when the time allowed does not permit a complete checkout. A mathematical model is developed for determining the optimum set of checks and the required capability of the checkout equipment. 40 pp. Illus. Published in the *Naval Research Logistics Quarterly*, March 1962. Presented before the Sixth Joint Military-Industry Guided Missile Reliability Symposium at Fort Bliss, Texas, February 15-18, 1960.

P-1854-RC. The link between science and invention: the case of the transistor. R. R. Nelson. 12-15-59. Unclassified.

A case study of basic research in industry. The study focuses on the factors affecting the allocation of research resources in a science-oriented industrial research laboratory. A history of the research that led to the transistor is presented, including a discussion of the payoffs expected, the uncertainties involved, how new information was obtained, how it affected the direction of the project, and the kind of interaction that existed among the several people working on the project. The organization and decision policies of the Bell Telephone Laboratories are described. An attempt is made to generalize on the characteristics of research and to assess what these characteristics imply relative to problems of research management. 54 pp. Illus. Presented before the Conference on the Economic and Social Factors Determining the Rate and Direction of Inventive Activity, held at the University of Minnesota, Minneapolis, Minnesota, May 12-14, 1960.

P-1856-RC. Economic welfare and the allocation of resources for invention. K. J. Arrow. 12-15-59. Unclassified.

A discourse on invention, defined broadly as the production of knowledge. From the viewpoint of welfare economics, determining optimal resource allocation for invention will depend on the technological characteristics of the invention process and on the nature of the market for knowledge. It is shown that the competitive system fails to achieve an optimal resource allocation in the case of invention because of increasing returns, inappropriability, and uncertainty. For an optimal allocation to invention, it is necessary for the government or some other agency not governed by profit-and-loss criteria to finance research and invention. 23 pp. Presented before the Conference on the Economic and Social Factors Determining the Rate and Direction of Inventive Activity, held at the University of Minnesota, Minneapolis, Minnesota, May 12-14, 1960.

P-1857. Optimum search routines for automatic fault location. S. I. Firstman and B. Gluss. 12-11-59. Unclassified.

A study concerned with automatic equipment that is being developed to diagnose malfunctions in equipment and to locate faulty parts. For use as an adjunct to the usual engineering-logic method of programming for fault location, this paper develops search rules, founded on probabilistic concepts, that show the preferred order of conducting tests to find the fault in the shortest time. A two-step search process is used, finding first the faulty module, and then the faulty component within the module. 18 pp. An abbreviated version of RM-2514. Published in *Operations Research*, July-August, 1960. Presented before the Sixth Joint Military-Industry Guided Missile Reliability Symposium at Fort Bliss, Texas, February 15-18, 1960.

P-1858. Invariant imbedding and mathematical physics—I: particle processes.

R. E. Bellman, R. E. Kalaba, and G. M. Wing. 3-21-60. Unclassified.

A derivation, using invariance principles in a systematic fashion, not only of new analytic formulations of the classical particle processes (namely, those of transport theory, radiative transfer, random walk, multiple scattering, and diffusion theory), but also of new computational algorithms that seem well fitted to the capabilities of digital computers. Whereas the usual methods reduce problems to the solution of systems of linear equations, an attempt is made to reduce problems to the iteration of nonlinear transformations. 116 pp. Illus. See also P-1113, P-1614, and P-2202. Published in *Journal of Mathematical Physics*, July–August 1960.

P-1859. Report on service with the American Exhibition in Moscow. J. R. Thomas. 3-15-60. Unclassified.

An account of the visit of one of the 75 Russian-speaking guides at the American Exhibition in Moscow during the summer of 1959. The author's observations and the many comments and opinions expressed to him during this time are presented. The background of the political climate in the Soviet Union is indicated by a description of the Exhibition as a major landmark in the U.S.-Soviet cultural exchange program and by a discussion of the environment in which the author's private meetings with Soviet citizens were held. While he met most people in Moscow, he also talked to others in Kiev, Leningrad, and Riga. 107 pp.

P-1860. Maximum total energy of the Van Allen radiation belt. A. J. Dessler and E. H. Vestine. 12-17-59. Unclassified.

A letter to the editor of the *Journal of Geophysical Research*, indicating that the results of the spherical harmonic analysis of the geomagnetic field places an upper limit on the energy that may be stored in the Van Allen radiation belt. 6 pp. Published in the *Journal of Geophysical Research*, March 1960.

P-1861. Space vehicle power plants. J. H. Huth. 12-22-59. Unclassified.

A survey of secondary power sources for space-vehicle operation. The demands for onboard space-vehicle electrical power are considered, as well as those environmental features peculiar to such an operation. Specific power supplies are also discussed. 74 pp. Illus. Submitted to McGraw-Hill as a chapter in a forthcoming book, "Handbook of Astronautical Engineering."

● **P-1862. The resolvability of point sources.** Peter Swerling. 12-8-59. Unclassified.

An investigation of the resolvability, in the presence of noise, of point sources that are separated in azimuth by less than the width of the main lobe of the gain pattern. The probability of correctly resolving two sources is derived for a particular class of decision methods as a function of the strengths of the sources, their angular separation, and noise level. Numerical results are presented for a case that corresponds more accurately to optical or infrared devices than to radar. 26 pp. Illus. Presented before the Symposium on Decision Theory at Rome Air Development Center, New York, May 11, 1960.

P-1863. The survey of the geomagnetic field in space. E. H. Vestine. 1-5-60. Unclassified.

A description of developments, early and late, in our understanding of the geomagnetic field near the earth and in surrounding space. When this field is better understood as a planetary feature, the history and nature of other planetary bodies possessing a magnetic field may be indicated. Knowledge of the geomagnetic field is also useful in navigation, in the geophysical prospecting for oil and minerals, and in surveying and other engineering applications. 34 pp. Illus. Published in the *Transactions, American Geophysical Union*, March, 1960. Presented before the Goddard Space Center, NASA, Washington, D.C., December 7, 1959.

P-1864. Ascent guidance for a satellite rendezvous. T. B. Garber. 12-1-59. Unclassified.

A discussion of the problem of guiding a vehicle to a rendezvous with a space platform or satellite. Rendezvous not only requires matching vehicle and satellite positions, but the two velocity vectors must also be identical. A further complication is that the geometric relationship between a given launch site and the satellite is a function of time. As a consequence, the ascent trajectory is generally nonplanar, and the time of launch is a critical factor. For an ideal rendezvous, the vehicle must be guided so that at the end of propulsion its three components of velocity and position are the same as the corresponding satellite variables. In practice, the residual errors in

position and velocity at the end of the ascent phase serve as the initial conditions for a terminal guidance period during which the vehicle is brought into proximity with the satellite. 24 pp. Illus. Presented before the National Symposium on Manned Space Stations at Los Angeles, California, April 20-22, 1960, and published in the proceedings of the Symposium.

- **P-1865. On the future of operations research in the aircraft and space systems industries.** R. A. Davis and R. Schamberg. 12-14-59. Unclassified.

An outline of the ever-expanding scope of operations-research activity applied to aircraft, missile, and space systems. The search for preferred operational concepts is considered as a promising area for operations research in the future. Several suggestions are made for improving the effectiveness of operations research performed by the aero-space industries. Problem areas deserving concentrated operations-research effort by the space industry are also discussed. 12 pp. Illus. Presented before the Operations Research Society of America at Pasadena, California, November 12, 1959.

- **P-1866. Automatic language-data processing in sociology.** D. G. Hays. 12-29-59. Unclassified.

A discussion of the possibility of using computers to analyze mass communications, interaction transcripts, and other sociological data expressed in natural language. A method of grammatic analysis is described, and techniques for automatic content analysis and interaction process analysis are given. The need for research on the relations between linguistic and social variables is emphasized. 33 pp. Illus. Presented before the American Sociological Association at Chicago, Illinois, September 3, 1959.

- **P-1867. How much automaticity for checkout equipment.** S. I. Firstman. 1-4-60. Unclassified.

A method of programming (e.g., digital computer or paper tape system with manual decision) that determines the degree of automaticity of a checkout system. The implications that the choice of programmer carries for an automatic checkout system are discussed, and it is indicated how the characteristics of the system being checked and the anticipated operational conditions affect the selection of the programmer type and associated degree of automaticity. 24 pp. Illus. Incorporated in R-358. Presented before the American Rocket Society at Detroit, Michigan, March 24 and 25, 1960.

- **P-1868. Logistics research and management science.** M. A. Geisler. 12-29-59. Unclassified.

A discussion of the many useful contributions made to the management of the logistics system of the United States Air Force through the application of research techniques. In particular, the author describes the broad nature of the military environment, the planning process, the operations phase, and how the various logistics research activities relate to these aspects of the logistics system. 19 pp. Published in *Management Science*, July 1960.

- **P-1869. Power: the idea and its communication.** W. P. Davison. 12-31-59. Unclassified.

A paper prepared for the Fifth Annual World-wide Information Service Seminar at New York City, November 5, 1959, and published in the proceedings of the Seminar. Part I deals with theoretical ideas about power: what it is, the various forms in which it exists, and the different attitudes individuals and nations have toward these various forms. Part II discusses the problems of military public information in communicating the idea of power. Military demonstrations are especially useful for this purpose, but are often open to a large number of interpretations. For instance, researchers have found a wide range of public reactions to such demonstrations as the Berlin airlift and the Soviet satellite launchings. If the military public-information specialist is familiar with the ideas about power that are held by members of his audience, he will be more effective in interpreting military events for them. 28 pp.

- **P-1870. Asymptotic behavior of solutions of linear parabolic equations.** R. E. Bellman and K. L. Cooke. 1-6-60. Unclassified.

An application of a method for analyzing the asymptotic nature of solutions of linear differential equations and linear differential-difference equations to the study of partial differential equations possessing a certain integral representation, essentially a convolution transform, which exists for the solution. This paper considers the parabolic equation $u_t = u_{xx} + \phi(x)a(t)u$, with the boundary

conditions $u(0, t) = u(1, t) = 0, t > 0$. Subsequent papers will apply the method to other types of functional equations. 6 pp.

P-1871. Theory and policy in the French nationalized industries. T. A. Marschak. 1-15-60. Unclassified.

A survey showing the impact of French economic theorists on public policy in France. This paper considers the studies performed by members of, or at the request of, the Electricité de France (EDF), Charbonnages de France (coal mines), SNCF (railways), and Gaz de France. The major question involved is that of determining whether the principles of welfare economics suggest policies for the nationalized industries that are practicable and better than the inherited policies. The specific problem areas discussed deal with the choice of investment projects for fixed-capital budgets, the pricing of outputs, inventory decisions, and the relations between the nationalized industries. 43 pp. Illus. Published in *The Journal of Business*, April 1960.

P-1872. Taxation and the demand for alcoholic beverages. W. A. Niskanen. 1-11-60. Unclassified.

A study of the characteristics of aggregate consumer demand for alcoholic beverages and the influence of changes in the alcoholic-beverage taxes on this aggregate demand. Estimates of these effects may help to determine how effective these taxes are as instruments of public policy. Part I presents an econometric model of the markets for distilled spirits, beer, and wine. Part II suggests and tests three hypotheses to explain the changes in the actual tax rates since 1934. 14 pp. Illus. Presented before the Econometric Society at Washington, D.C., December 29, 1959.

P-1873. The terms of Soviet-Satellite trade: a broadened analysis. Horst Mendershau-sen. 1-7-60. Unclassified.

An extension of P-1598, which concludes that, during 1955 through 1957, the Satellites conducted trade with the USSR on generally less favorable terms than did Free Europe. Through the publication of Soviet foreign-trade data for 1958, this paper expands the previous analysis in an attempt (1) to test the belief that the application of "world market prices" in intra-Bloc trade, and the elimination of price discrimination, needed more time to make themselves felt in the terms of trade of the Satellites and (2) to expand the analysis of Soviet trade with Satellites and Free Europe in breadth, by a slight enlargement of the commodity sample, and in depth, by the study of individual country situations and the development of approximate price indexes of Soviet trade with European Bloc and non-Bloc countries. 51 pp. Illus. Also published as RM-2507-1-PR. Published in *The Review of Economics and Statistics*, May 1960.

● **P-1874. Design and operation of ground guidance systems.** D. E. Lewis. 1-7-60. Unclassified.

A description of several kinds of guidance techniques for use on surface-to-surface ballistic missiles and for possible use in space exploration. The techniques examined are initial guidance, midcourse guidance, and terminal guidance. Despite the type of guidance, however, such factors as alignment accuracy, simplicity of design, and a check of the system's components for operational capability must be considered for the effective design and operation of any ground guidance system. 48 pp. Incorporated in *Ground Support Systems for Missiles and Space Vehicles*, ed. by K. Brown and P. B. Weiser, published by McGraw-Hill Book Company, Inc., New York, 1961. \$15.00. Presented as a lecture at the University of California at Los Angeles, February 29, 1960.

P-1875. Effect of a transverse magnetic field on the "escape speed" of a conducting fluid. Carl Greifinger. 5-9-60. Unclassified.

A discussion of the effect of a transverse magnetic field on the "escape speed" of a perfectly electrically conducting fluid. This paper indicates that (1) for a given initial ratio of the magnetic pressure to the hydrodynamic pressure in the conducting fluid, the "escape speed" is not uniquely defined, but depends on the magnetic pressure in the vacuum into which the fluid is expanding; and (2) the integrals appearing in the generalized Riemann invariants can be evaluated analytically. 8 pp. Illus. Published in *The Physics of Fluids*, July-August 1960.

P-1876. Upper atmosphere studies. W. W. Kellogg. 1-16-60. Unclassified.

A summary of advances in the field of upper-atmosphere research that have occurred during and since the I.G.Y. Recent observations with rockets and satellites are emphasized. 12 pp. Illus. See

also P-1813. Included in the Triennial Report of the American Geophysical Union (AGU) to the International Union of Geodesy and Geophysics (IUGG), presented at the IUGG meetings at Helsinki, Finland, July–August 1960.

P-1877. On the value of overseas bases. A. J. Wohlstetter. 1-5-60. Unclassified.

A defense of overseas bases in view of a recent article in *Air Force* by Major General Dale O. Smith. While both General Smith and the author agree on the importance of overseas bases, some points cited by General Smith from P-1472 are discussed, together with some questions of offense strategy. The factors examined are (1) the role of overseas bases in both nuclear and non-nuclear limited wars and in providing a second-strike capability; (2) the simultaneous impact strategy and the amount of warning obtained by overseas bases from radar detection of missiles bound for United States targets; and (3) the decision problem of firing missiles. Our overseas bases continue to have many uses and, like our alliances, are indispensable. 16 pp. Published in *Air Force and Space Digest*, May 1960.

● **P-1878. Main street, the moon, and what next?** H. P. Lynn, Jr. 12-7-59. Unclassified.

A talk on some important factors of space exploration. An attempt is made to determine how we stand technically in our space programs by discussing such problem areas as propulsion, guidance, and crew facilities. Answers as to why we are involved in space programs are found in the increase in knowledge of the Earth and of ourselves, in the practical dollars and cents applications, and in our struggle for survival with the Soviet Union. A good sound program of research and development is justified. Whether these ventures are civilian or military, the potential value of a bold, imaginative, and extensive program is enormous. 24 pp. Presented before the Blessed Sacrament Holy Name Society at Washington, D.C., December 7, 1959.

P-1879. The accuracy of winds derived by the radar tracking of chaff at high altitudes. R. R. Rapp. 1-7-60. Unclassified.

A discussion of the accuracy and significance of wind measurements made by radar tracking of high-altitude chaff in the vicinity of Johnston Island, July–August, 1958. The manner in which the chaff responds to changes in the wind is deduced from the observed rates of fall. The standard error of the wind determination caused by random errors of tracking is estimated statistically. It is shown that day-to-day variations of the wind at a level are detectable with this type of measurement, but that day-to-day variations of the shear are masked by instrumental error. The mean shear over the 3-day period, however, is found to be real and may be caused by a change in wind regime associated with the temperature minimum near 80 km. 25 pp. Illus. Published in *Journal of Meteorology*, October 1960.

P-1880. Atmospheric extinction of infrared radiation. Diran Deirmendjian. 1-7-60. Unclassified.

An analysis of the effects of scattering on the transmission of radiation in the 2.6- to 12-micron region. Monochromatic extinction coefficients are determined from the individual extinction cross sections, based on the complex index of refraction for water. The results agree well with experiment except in the 8- to 12-micron region, where water-vapor "wing" absorption appears to be present. The extinction characteristics of a simple cloud model are included. 26 pp. Illus. Published in *Quarterly Journal of the Royal Meteorological Society*, July 1960.

P-1881. Comparisons of United States and USSR national output: some rules of the game. A. S. Becker. 2-15-60. Unclassified.

An attempt to show that a prerequisite to public understanding of where we stand in the economic competition with the Soviet Union is observance of a few critical rules in framing comparisons of the United States and Soviet economies. In summarizing the rules it is found that comparisons of national output or its components must yield divergent measures of the ratio of absolute values, that the average of the divergent ratios has no intrinsic meaning, and that despite the large divergence of the real ratios, the average ratio may not be used to develop absolute USSR values from corresponding U.S. dollar values, especially for structural comparisons. 16 pp. Published in *World Politics*, October 1960.

P-1882. A model for evaluating fleets of transport aircraft. J. R. Summerfield. 1-12-60. Unclassified.

A description of a Monte Carlo model used in evaluating the capability of both actual and possible transport systems to meet the airlift demands of the United States military establishment. The model includes peacetime flying activities, wartime deployments, and the transition from peace to war. Transports fly through a simulated route structure according to rules determined by aircraft and load characteristics and by random elements of wind, temperature, and aircraft maintenance. A fleet's performance is judged by its cumulative delivery, over time, of materiel and personnel to a specified combat zone. In this way, the model helps to make comparisons among different transport fleets and can also be used to detect bottlenecks in a particular transport system. 15 pp. Illus. Presented before the Second International Conference on Operational Research at Aix-en-Provence, France, September 5-9, 1960, and published in the proceedings of the Conference.

P-1883. Comments on some aspects of corporate planning in the defense industry. G. H. Fisher. 1-18-60. Unclassified.

An attempt to indicate the importance of viewing the bases for long-range corporate planning in a context that takes explicit account of uncertainty. Corporate planning is defined, decisionmaking under conditions of uncertainty is discussed, the uncertainties of environment are applied to the problem of long-range corporate planning, and some illustrative samples are presented. 26 pp. Illus. Presented before the Conference on Forecasting in the Defense Industry, held at the University of California at Los Angeles, May 5-6, 1960.

P-1885. An algorithm for the mixed-integer problem. R. E. Gomory. 6-23-60. Unclassified.

An algorithm for the numerical solution of the "mixed integer" linear-programming problem. This problem is one of maximizing a linear form in finitely many variables constrained both by linear inequalities and by the requirement that a proper subset of the variables assume only integral values. The algorithm is an extension of the cutting plane technique for solving the "pure integer" problem. 12 pp. See revised version RM-2597. Presented before the American Mathematical Society at Philadelphia, Pennsylvania, January 20-22, 1959.

P-1886-FF. Decisionmaking in the schools: an outsider's view. J. A. Kershaw and R. N. McKean. 1-19-60. Unclassified.

An attempt to present a framework that will help school board members and administrators to cope with the many decisions with which they are constantly faced. The approach to decisionmaking is considered first. Then a numerical example is presented that illustrates this approach to decisionmaking and that shows how more nearly scientific comparisons of school policies can be made. 14 pp. Table. Published in *School Management*, May 1960.

P-1887. Soviet civil defense. Leon Gouré. 3-14-60. Unclassified.

A description of the Soviet civil-defense program, based on the many Soviet publications issued in connection with the program. Such aspects of the program are discussed as its background, basic Soviet civil-defense theory, organization, training, means of protection, shelter habitability, evacuation, preattack measures, and postattack operations. While Soviet citizens are relatively apathetic toward civil defense, it is likely that in time of crisis they would respond to their training. They know that the Soviet authorities are prepared to enforce obedience and to ruthlessly punish any unauthorized or panic-inspired behavior. 21 pp. Incorporated in a book entitled *Civil Defense in the Soviet Union*, published by the University of California Press, Berkeley, California, 1962. \$4.95. Presented before the Conference on Civil Defense, held at the National Academy of Sciences, Washington, D.C., February 11-12, 1960, and published in the proceedings of the Conference.

P-1888-RC. The nature and feasibility of war and deterrence. Herman Kahn. April 1960. Unclassified.

An evaluation of the impact of a thermonuclear war, and a description of some of the risks that might cause decisionmakers to weigh the alternatives of whether or not to go to war (namely,

genetic problems, postwar medical problems, and long-term recuperation). The kinds of deterrence discussed are (1) deterrence of a direct attack, (2) the use of strategic threats to deter an enemy from engaging in very provocative acts other than a direct attack on the United States, and (3) acts that are deterred because the potential aggressor is afraid that the defender or others will take limited actions, military or nonmilitary, to make the aggression unprofitable. 46 pp. A revised version of an article of the same title published in the Stanford Research Institute *Journal* for the fourth quarter of 1959. An abbreviated version of the SRI article printed in *U.S. News and World Report*, December 21, 1959. Incorporated in pamphlet entitled *Three Lectures on Thernonuclear War*, published by Princeton University Press, Princeton, New Jersey, 1960.

P-1889. Empirical relationships for jet-flap lift and drag prediction. D. J. Blakeslee. 1-21-60. Unclassified.

A presentation of empirical relations for the prediction of the lift and drag of unswept three-dimensional jet-flapped wings, together with the necessary inputs. Plotted data show that the equations organize lift and drag data with a consistency sufficient for preliminary-design use in the ranges $1 \leq C_{\mu} \leq 50$, $3 \leq AR \leq 10$. 15 pp. Illus. Published in *Aerospace Engineering*, November 1960.

P-1890. Atmospheric entry of manned vehicles. Carl Gazley, Jr. 1-20-60. Unclassified.

A study of various system requirements and penetration techniques for achieving reliable atmospheric re-entry of manned vehicles from a space-station orbit. From an examination of the dynamics of deceleration and surface heating, two feasible vehicle designs are suggested: (1) a blunt, dense vehicle with little or no aerodynamic lift and with a low-temperature ablation-cooling system, and (2) a radiation-cooled vehicle using a very light drag brake or lifting surface to achieve high-altitude deceleration. 41 pp. Illus. Also published as RM-2579. Published in *Aerospace Engineering*, May 1960. Presented before the National Symposium on Manned Space Stations at Los Angeles, California, April 20-22, 1960.

• **P-1891. Powerplants for atmospheric and surface vehicles on Mars.** W. H. Krase. 1-25-60. Unclassified.

A study of possible powerplants that include atmosphere-breathing systems using nuclear and chemical heat sources, chemical rockets, and a rocket-turbine in which rocket-chamber exhaust feeds a turbine to produce shaft power. The rocket-turbine results in a lightweight powerplant useful not only on Mars and other planets but also on Earth. The technology required to develop it is available. 25 pp. Illus. Presented before the IAS (Institute of the Aeronautical Sciences) National Flight Propulsion Meeting at Cleveland, Ohio, March 10-11, 1960.

P-1892. How good is the Lunik III moon photography? M. E. Davies. 1-4-60. Unclassified.

A comparison of the quality of the released Soviet pictures of the back side of the moon with that of conventional, earth-originated photographs of the front side. 9 pp. Illus. Supplements P-1671. See also P-1969. Published in *Astronautics*, May 1960.

P-1893. The optimum detection of analog-type digital data. Edward Bedrosian. 1-28-60. Unclassified.

A discussion of ways of minimizing the effects of errors in communications systems transmitting an analog quantity. 6 pp. Illus. Published in *Proceedings of the IRE*, September 1960.

P-1894. Communist China and nuclear warfare. A. L. Hsieh. 2-1-60. Unclassified.

An investigation of the nature of the Chinese response to the revolution in weaponry and strategic thinking that had occurred outside China in the very period during which the Chinese Communists were gaining and consolidating their power. The divisive effect that a growing appreciation of the implications of nuclear warfare had on Chinese military circles and on relations between the Party and the Army is considered, together with the significance of the evolving Chinese attitudes for the Sino-Soviet strategic relationship. 20 pp. Published in *The China Quarterly*, April-June 1960.

• **P-1895. The evaluation of the effect of the environment on a complex operation.** J. D. Sartor. 1-29-60. Unclassified.

A method for evaluating the effect of environment on a complex operation. The method is applied to a reconnaissance operation as an example of its use in a climatological study. The concepts

presented can also be used for determining the relative value of an operational forecast. 14 pp. Illus. See also RM-2080 and RM-2322. Presented before the Third National Conference on Applied Meteorology at Santa Barbara, California, April 4-8, 1960.

P-1896. Soviet research in machine translation. K. E. Harper. 2-4-60. Unclassified.

A survey that indicates that Soviet researchers are attacking the problem of machine translation on a broad front. Substantial achievements have been recorded in the analysis of input text, in the development of specialized glossaries, and in the creation of analytic and synthetic translation programs. The application of machine techniques in this research appears to be limited. However, a significant breakthrough in automatic language translation can be expected if, and when, computer facilities are made available. 19 pp. Presented before the National Symposium on Machine Translation at the University of California at Los Angeles, February 2-5, 1960, and published in the proceedings of the Symposium.

P-1898. On the stability of solutions of the linearized plasma equation. R. E. Bellman and J. M. Richardson. 2-2-60. Unclassified.

An approach to a certain equation that is a linearized version of a basic equation in plasma physics. From a derivation of a relation equivalent to the usual dispersion relation, but of more convenient form, this paper obtains some simple criteria for stability of solutions of this equation. 8 pp. Published in the *Journal of Mathematical Analysis and Applications*, December 1960.

P-1899. The separation of uranium isotopes by gaseous diffusion: a linear-programming model. D. M. Fort. 2-2-60. Unclassified.

A description of a linear-programming model of the gaseous-diffusion process for separating uranium isotopes. The model is intended primarily as a component of larger models involving interactions between the gaseous-diffusion process, nuclear reactors, and other facilities of the nuclear-materials industry. The model discussed concerns an idealized version of the gaseous-diffusion process in steady-state operation. The types of relations considered are the material balance within the plant, the scale of plant required to generate given material flows, and the irreversible nature of the gaseous-diffusion process. This paper suggests the importance of the irreversible nature of the gaseous-diffusion process in certain applications and describes a way to handle it by linear programming. 16 pp. Illus. Presented before the Second International Conference on Operational Research at Aix-en-Provence, France, September 5-9, 1960, and published in the proceedings of the Conference.

P-1900. Linguistic research at The RAND Corporation. D. G. Hays. 2-2-60. Unclassified.

A paper that examines postediting rules for description of function in context, work on computational routines for semi-automatic analysis, the concept of idiom-in-structure, and two problems concerned with grammatic transformation and distributional semantics. The latter problems are especially important for automatic indexing, abstracting, and text searching. 22 pp. Presented before the National Symposium on Machine Translation at the University of California at Los Angeles, February 2-5, 1960, and published in the proceedings of the Symposium.

ØP-1901-RC. Strategy and organization in a system development project. T. A. Marschak. 2-3-60. Unclassified.

An illustration of the possibilities of case studies of system-development projects to determine development strategies and types of project organization associated with both successful and unsuccessful system development. The case study presented, known as the TH system, is a microwave relay system for the transmission over long distances, via a chain of relay towers, of telephone conversations and television signals. The paper discusses the system's general strategy of development, its organization, and a hypothesis about strategy and organization of system projects with which the case of TH seems consistent. 57 pp. Illus. Presented before the Conference on the Economic and Social Factors Determining the Rate and Direction of Inventive Activity, held at the University of Minnesota, Minneapolis, Minnesota, May 12-14, 1960, and published in the proceedings of the Conference.

- **P-1902. Strategic gaming.** Olaf Helmer. 2-10-60. Unclassified.

The use of some exhibits, relating to a strategic procurement game, to explain various concepts and techniques of operational gaming. In particular, the paper discusses the relative merits (1) of play by human players versus machine play and (2) of rigid rules versus umpire rulings. The roles of the experts in different aspects of gaming are also described. 21 pp. Illus. Presented before the 5th SHAPE Operations Research/Scientific Advisory Conference at Paris, France, May 18-20, 1960.

- **P-1903. On the foundations of a theory of stochastic variational processes.** R. E. Bellman. 2-9-60. Unclassified.

An outline of the principal steps in constructing a theory of stochastic variational processes of continuous type by means of dynamic-programming theory. The foundations are rigorously laid by using parts of the theory of discrete stochastic variational processes as building blocks, and then by using a passage to the limit in various ways. 26 pp. Presented before the Tenth Symposium on Applied Mathematics at New York, New York, April 14-15, 1960.

- P-1904. Economic development and the employment of resources.** F. T. Moore. 2-5-60. Unclassified.

A paper presented before the Conference on Natural Resources and Economic Growth at Ann Arbor, Michigan, April 7-9, 1960. In considering the problems of economic growth that face underdeveloped countries, the author discusses (1) the theory of balanced and unbalanced growth, (2) the neo-classical competitive model of the economy to discover whether it provides a useful framework for analyzing the conditions in underdeveloped countries and whether derived norms can be derived for policies that will help to accelerate the growth of these countries, and (3) some empirical evidence on questions concerning the existence of external economies, the effects of technological change, and the relative costs of development of various sectors in the economy. 42 pp. Incorporated in *Natural Resources and Economic Growth*, ed. by J. J. Spengler, published by Resources for the Future, Inc., Washington, D.C., 1961. \$3.50.

- P-1905. Differences between the personal demand for money and the business demand for money.** J. J. McCall. 2-8-60. Unclassified.

An investigation of the differences between personal demand for money and business demand for money. It is concluded (1) that the synchronization of debits and credits in the business sector is superior to synchronization in the personal sector, (2) that the person is more uncertain about his average transactions over a period of time than is the business firm, (3) that business turnover is greater than personal turnover, and (4) that while personal debits and deposits are unrelated, there is a significant positive relation between business debits and deposits, that is, business turnover is more stable than personal turnover. 35 pp. Illus. Published in *The Journal of Political Economy*, August 1960.

- **P-1906. Dynamic programming and Gaussian elimination.** R. S. Lehman. 3-21-60. Unclassified.

An extension to P-917, *On Some Applications of Dynamic Programming to Matrix Theory*, which demonstrates that the functional-equation technique of dynamic programming leads to an algorithm for solving linear equations when the matrix is a Jacobi matrix. This paper shows that the algorithm is essentially the same as Gaussian elimination. 7 pp.

- P-1907. On the noise temperature of coupling networks.** Edward Bedrosian. 2-10-60. Unclassified.

A derivation of the noise temperature of the output from a source and from a passive coupling network. 2 pp. Published in *IRE Transactions on Microwave Theory and Techniques*, July 1960.

- **P-1908. Propulsion requirements for rendezvous in orbit.** Eugene Levin. 2-11-60. Unclassified.

A review of gross orbit transfers and of several proposed terminal-guidance techniques to obtain information on the size, type, and characteristics of the propulsion system required for an orbital rendezvous operation. 29 pp. Illus. Presented before the National Flight Propulsion Meeting of the Institute of the Aeronautical Sciences at Cleveland, Ohio, March 10-11, 1960.

P-1909. Glossary lookup made easy. H. S. Kelly and T. W. Ziehe. 2-29-60. Unclassified.

A discussion of the dictionary problem for machine translation. Attempts have been made to reduce the amount of information involved and to bring the problem within the capabilities of presently available or soon-to-be available computing equipment. This paper presents a technique for handling the problem with currently available computing equipment and without the complexities of information compression. The approach used is to compile a glossary of forms from the current text and then to retrieve information about each from the dictionary as the information is needed in the translation process. 16 pp. Presented before the National Symposium on Machine Translation at the University of California at Los Angeles, February 5, 1960, and published in the proceedings of the Symposium.

P-1910. Grouping and dependency theories. D. G. Hays. 2-16-60. Unclassified.

A discussion of immediate-constituent analysis and dependency analysis. These two theories of syntactic description are based, respectively, on the topologies of grouping and of trees. A correspondence between structures of the two types is defined, and the two topologies are compared, mainly in terms of their empirical applications. These theories are of interest because of their application to machine translation. 12 pp. Illus. Also published as RM-2646. Presented before the National Symposium on Machine Translation at the University of California at Los Angeles, February 5, 1960, and published in the proceedings of the Symposium.

P-1911. Some mathematical aspects of optimal predation in ecology and bovine culture. R. E. Bellman and R. E. Kalaba. 3-8-60. Unclassified.

An attempt to show how the functional-equation technique of dynamic programming can be used in formulating and solving—both analytically and numerically—a variety of problems of optimal predation. In determining optimal predation policies, the paper stresses the control, as opposed to the descriptive, aspects of predation processes. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, May 1960.

P-1913. A conservative estimate of the meteoroid penetrating flux. R. L. Bjork. 2-11-60. Unclassified.

Conservative estimates, from a vehicle-design viewpoint, (1) of the meteoroid flux as a function of mass and (2) of the meteoroid effects as a function of mass, velocity, and density. The penetrating flux for a sheet of aluminum or steel in space is deduced from these estimates. 11 pp. Illus. Presented before the Symposium on Systems for Nuclear Auxiliary Power at Washington, D.C., December 2-4, 1959, and published in the proceedings of the Symposium.

P-1914. Allocation of two types of aircraft in tactical air war: a game-theoretic analysis. L. D. Berkovitz and M. Dresher. 2-18-60. Unclassified.

An analysis, as a two-sided war game, of the problem of allocating two types of aircraft (bombers and fighters) among three different air tasks (counter air, air defense, and support of ground operations) in a multistrike campaign. It is assumed that a bomber can be used in either the counter-air or ground-support operations, while a fighter can be used in either the air-defense or ground-support roles. That is, bombers and fighters have the one task of ground support in common. Optimal employment during the last strikes of the campaign consists in a concentration of all resources on support of ground operations. Optimal employment during the early strikes of the campaign requires randomization by both sides. 27 pp. Illus. Also published as RM-2399. See also P-1533. Published in *Operations Research*, September–October 1960.

P-1915. Celestial frontiers. G. H. Clement. 3-23-60. Unclassified.

A talk presented before the joint annual meeting of the American Congress on Surveying and Mapping and of the American Society of Photogrammetry, held at Washington, D.C., March 23, 1960. Several aspects of celestial frontiers are discussed: the contribution of celestial mechanics to engineering, the rate of progress to expect in probing these frontiers, and future challenges in contrast to past aerospace developments. 19 pp. Illus. Published in *Surveying and Mapping*, June 1960, and in *Photogrammetric Engineering*, June 1960.

- **P-1916. The decisionmaking problem in development.** B. H. Klein. 2-19-60. Unclassified.

Part of a continuing study designed to improve the conduct of military research and development. This paper indicates the aspects in which the decisionmaking problem in development is different from that in production decisions. The nature of the uncertainties involved in development decisions is discussed, together with the decisionmaking problem. The author shows the similarity between the conclusions of this paper and the idea advanced by Schumpeter that the conditions required for an efficient allocation of existing resources are not the same as the conditions required for rapid economic progress. 30 pp. Illus. Presented before the Conference on the Economic and Social Factors Determining the Rate and Direction of Inventive Activity at the University of Minnesota at Minneapolis, Minnesota, May 12-14, 1960.

- **P-1917. Psychological inspection.** L. C. Bohn. 2-19-60. Unclassified.

A description of the "psychological inspection" approach to the problem of disarmament. By this method violations of an arms-control agreement will be sought in people, not in places. Psychological inspection will concentrate on people at various levels with knowledge of violation, rather than on the physical violations themselves. This approach appears most promising because of its wide applications to actions on which limitations may be placed by an international arms-control agreement, and as a supplement to more conventional "physical" inspection techniques and systems. 35 pp.

- **P-1919. Soviet scientific and technical literature: sources and availability.** Rosemary Neiswender. 2-23-60. Unclassified.

An attempt to provide a unified, centralized approach for procuring specific Soviet literature in scientific and technical fields. The areas are defined in which valuable Russian material is available, and avenues of access to that material are indicated. The author considers Soviet scientific and technical literature as it appears in translation (for the non-Russian readers) and as it appears in the original language. This study may aid both librarians and technical personnel in obtaining needed information on significant Soviet material. 18 pp. Presented before the BMD Technical Information Conference at Washington, D.C., March 2-4, 1960.

- **P-1920. A comparison of hydrodynamic and electrostatic forces on cloud droplets.** J. D. Sartor and M. H. Davis. 2-23-60. Unclassified.

A computation of hydrodynamic and electrostatic forces on cloud droplets within the viscous-flow range. For a typical case, in which the hydrodynamic forces prevent collision of the droplets, it is shown that the addition of a uniform electrostatic field comparable to those observed in clouds causes the droplets to collide. 11 pp. Illus. Presented before the 8th Weather Radar Conference at San Francisco, California, April 11-14, 1960, and published in the proceedings of the Conference.

- **P-1921. The vertical motion of solid spheres in the atmosphere.** R. R. Rapp. 2-18-60. Unclassified.

The development of a general equation of motion for spherical objects falling through the atmosphere. A method is described for computing terminal velocities over a wide range of elevation and particle size, and the manner in which certain spheres approach terminal velocity from rest is investigated. Finally, the effect of oscillatory motions on very small spheres is discussed. 23 pp. Illus.

- **P-1922. Traces, term ranks, widths and heights.** D. R. Fulkerson and H. J. Ryser. 2-29-60. Unclassified.

A discussion of the notions of widths and heights of $(0, 1)$ -matrices, previously introduced by the authors, in the general setting of known results concerning traces and term ranks. Proofs are omitted. 18 pp. Published in *IBM Journal of Research and Development*, November 1960.

- **P-1923. Applications of dynamic programming to space guidance, satellites, and trajectories.** R. E. Bellman, S. E. Dreyfus, and R. E. Kalaba. 2-7-61. Unclassified.

An application of a new mathematical technique, based on the theory of dynamic programming, to the computational solution of trajectory problems. This method has already resolved many problems, seemingly inaccessible to the conventional methods of the calculus of variations, and permits

a study of more complex physical problems with the use of quite elementary mathematical concepts. 11 pp. Illus. Presented before the Symposium on Ballistic Missiles and Space Technology at the University of California at Los Angeles, August 24-27, 1959, and published in the proceedings of the Symposium.

P-1924-RC. The potential of electronic data processing in municipal government.
E. F. R. Hearle. 2-26-60. Unclassified.

An examination of the major characteristics of electronic data-processing (EDP) equipment and of the use of computers in solving municipal problems. Almost all municipal activities using information can be described in terms of input, processing, storage, and output. The computer can conduct this operation in a period of time measured in thousandths of one second. The concept that EDP is too costly for small cities will be obsolete by 1980. During the next decade we should analyze our decisionmaking processes and design municipal information systems to take full advantage of the capability provided by our technology. 8 pp. Published in *Western City Magazine*, March 1960.

P-1925. Soviet strategic ideas, January, 1960. H. S. Dinerstein. 3-4-60. Unclassified.

An analysis of a speech made by Khrushchev to the Supreme Soviet on January 14, 1960, and of two speeches by Malinovskii. One of the Malinovskii speeches was made in the Supreme Soviet on January 14, and the other was presented to a military group in Moscow on January 19. The main themes of these speeches are (1) that the Soviet Union will continue to develop new weapons until a general disarmament agreement is reached and will continue to use nuclear blackmail for political purposes, (2) that the Soviet Union is now "unassailable" and hopes still to be the first to strike if war comes, and (3) that the danger of a third world war arises from the West German search for revenge. 32 pp. Also published as RM-2532. Published in *Soviet Survey*, October-December 1960.

P-1926. MIMIC: a translator for English coding. H. S. Kelly. 3-7-60. Unclassified.

A description of MIMIC, an automatic coding system developed to provide rapid implementation, testing, and modification of computer routines for linguistic research. A *translator* analyzes and translates English-like statements into a pseudo-code program. An *interpreter* subsequently executes the program. The system is being used to program rules for insertion and inflection in a Russian-English translation routine. 17 pp. Presented before the Machine Translation Symposium at the University of California at Los Angeles, February 5, 1960, and published in the proceedings of the Symposium.

● **P-1927. Lecture on civil defense.** H. H. Mitchell, M.D. 3-2-60. Unclassified.

A talk presented before the Staff College of the New York State Civil Defense Commission at West Point, New York, February 9, 1960. Such aspects of civil defense are stressed as its effect on alleviating the catastrophe of a nuclear attack on the United States, the necessity of preparations to reconstruct and reconstitute our nation to its preattack status, and its contribution to U.S. freedom of action in conducting peacetime foreign policy and in implementing a broad deterrence strategy. The casualty problem at Hiroshima and Nagasaki is reviewed. RAND's civil-defense study, begun in 1957, is described, and the objectives of the program are summarized (namely, whether a civil-defense program is feasible, and whether a feasible program can be devised to make a plausible case for implementing it). 10 pp. Illus.

P-1929. An introduction to Information Processing Language V. A. Newell and F. M. Tonge. 3-4-60. Unclassified.

An introduction to Information Processing Language V (IPL-V), a symbol and list-structure manipulating language presently implemented on the IBM 650, 704, and 709. The paper discusses the problem context, in which a series of Information Processing Languages has developed, and the basic concepts incorporated in IPL-V. A complete description of the language can be found in IPL-V Programmer's Manual. 28 pp. Illus. Presented before the Association for Computing Machinery at Boston, Massachusetts, September 2, 1959. Published in the *Communications of the Association for Computing Machinery*, April 1960.

● **P-1930. Perturbation and renormalization**—I. R. E. Bellman and J. M. Richardson.
3-8-60. Unclassified.

A new formalism for obtaining the perturbation solution of a nonlinear equation. The particular equations written are used to illustrate the technique, which is quite general. Although this method

is known in the literature of mathematical physics in particular cases, its scope has not apparently been exploited in the mathematical domain. This paper obtains the first term of the perturbation expansion. Other papers in the series will deal with the application of the technique to more complex functional equations and to specific physical problems, the derivation of asymptotic expansions, and the problem of validating the technique. 11 pp.

● **P-1931. Wireline data transmission.** C. R. Lindholm. 3-7-60. Unclassified.

A discussion of the problems of high-speed data transmission over telephone lines. A few specific systems are examined to illustrate trends in system design, and suggestions are made for future data-transmission systems. 16 pp. Presented before the Institute of Radio Engineers Professional Group on Communications Systems at Los Angeles, California, December 8, 1959.

P-1932. Sixty years of growth in computing and data-processing capability. R. L. Petruschell. 3-8-60. Unclassified.

The results of a recent examination of the computing and data-processing productivity over the last 60 years. The charts presented show (1) the single-address speed of a number of representative machines at particular points in time and (2) the time-phased development of speed and storage capacity. 4 pp. Illus. Published in the *Communications of the Association for Computing Machinery*, April 1960.

● **P-1933. Numerical calculations of blast waves.** H. L. Brode. 2-16-60. Unclassified.

A discussion of the extensive numerical calculations used as a standard tool in the theory of blast waves. As exemplified by the collaborative work of Boyer, Brode, Glass, and Hall (1958), such solutions can provide valuable interpretation for experimental programs. Conversely, the application of such theoretical solutions to laboratory or field experience provides a desirable check on the limitations and physical approximations of the theory. This paper outlines the general steps in proceeding from physical assumptions to numerical answers for solutions by a Lagrangean coordinate, artificial viscosity method. 18 pp. Presented before a seminar at the University of Toronto, Institute of Aerophysics, at Toronto, Ontario, Canada, February 16, 1960.

P-1936. Comments on "The effect of micrometeorites on reflecting surfaces." R. L. Bjork. 2-29-60. Unclassified.

Comments made by the author, as discussion leader, following the presentation of the paper cited in the title at the national meeting of the Institute of Environmental Sciences at Los Angeles, California, April 6-8, 1960. 11 pp. Illus. Published in the proceedings of the Meeting.

● **P-1938. The peaceful atom in retrospect and prospect.** Arnold Kramish. 3-8-60. Unclassified.

A review of the world Atoms for Peace program announced by President Eisenhower before the United Nations on December 8, 1953. The economics of nuclear power in the 1960's is discussed in relation to the goals of this plan. The goals outlined are (1) to encourage worldwide investigation into the most effective peacetime uses of fissionable material, (2) to diminish the potential destructive power of the world's atomic stockpiles, (3) to have the great powers interested first in human aspirations rather than in armaments of war, and (4) to initiate a new approach for peaceful discussions. 12 pp. Presented before a luncheon for Cincinnati business leaders, sponsored by the Cincinnati Council on World Affairs, at Queen City Club, Cincinnati, Ohio, March 7, 1960.

● **P-1939. Use of the "expected value solution" in linear programming under uncertainty.** Albert Madansky. 3-11-60. Unclassified.

A discussion of the uncertainty involved in most linear-programming problems in either the technology matrix, the right-hand side, or the cost. Two methods of reducing the effects of uncertainty are to replace the random elements by their expected values (the "expected-value solution"), and to replace the random elements by pessimistic estimates of their values (the "fat" technique). This paper examines the use of these methods in the one-stage stochastic linear program and describes the relation between the one- and two-stage problem. The relation between the "fat" techniques used in the one-stage problem and the so-called "slack" techniques used in the two-stage problem is then determined. 15 pp. Presented before the Second International Conference on Operational Research at Aix-en-Provence, France, September 5-9, 1960.

P-1940. Polar magnetic, auroral, and ionospheric phenomena. E. H. Vestine. 3-10-60.
Unclassified.

A discussion of auroral and ionospheric phenomena. Contemporary studies of particles and fields in the upper atmosphere are described. Integral invariants are applied to auroral particles assumed trapped in the geomagnetic field. These, used with computations of the geomagnetic field above the earth, yield theoretical auroral isochasms and successfully locate both auroral zones. Auroral morphology and possible causes of auroral and geomagnetic phenomena are also examined. 16 pp. Illus. Published in *Review of Modern Physics*, October, 1960. Presented before the International Symposium on Magneto-Fluid Dynamics, National Academy of Sciences, at Washington, D.C., January 25, 1960.

● **P-1941. Machine translation of Russian prepositions.** K. E. Harper. 5-19-60.
Unclassified.

A description of the extent of the multivalence problem for prepositions in physics texts. Empirical studies, based on approximately 240,000 running words of Russian physics texts, reveal the extent of this translation problem. The contextual determinants of the translation of prepositions are studied; for each occurrence of a multivalent preposition, the syntactically related items (dependent and governor) are machine listed. The effect of these items on the translation of the preposition is summarized. 27 pp. Tables.

● **P-1942. Some analytical techniques for personnel planning.** William Gorham. 3-14-60.
Unclassified.

An application of operations analysis to a class of personnel problems. The problem considered is that of determining the retention rate, for a force of airmen in an Air Force service code, which has the best possible qualities on the average over the next 5 years. The most desirable retention rate is that which leads to a force with the lowest cost per unit of effectiveness. After a discussion of the criterion and constraints faced, the paper indicates the cost and effectiveness of the personnel in an Air Force service code for 5 years. 16 pp. Illus.

● **P-1943. Communist economic subversion: a reappraisal.** Hans Heymann, Jr. 2-9-60.
Unclassified.

A reappraisal of the significance of Communist economic activity in less-developed countries for the SEATO area and for the Free World. This paper attempts to determine whether Soviet economic competition is communist, economic, or subversive. As the Communist bloc envisages an ambitious role for its economic instrument, the effectiveness of this instrument is considered. Its attractions for the less-developed countries and its limitations as a policy tool are discussed. A possible solution for countering this long-run strategy is also suggested. 18 pp. Presented before the Second SEATO Countersubversion Seminar at Lahore, Pakistan, February 9, 1960.

● **P-1944. Electrical power from rockets.** J. H. Huth. 3-16-60. Unclassified.

A discussion of the characteristics of magnetohydrodynamic generators, as applied to ground-based chemical-rocket exhausts. Rocket-powered magnetohydrodynamic generators are suited to applications requiring hundreds or thousands of electrical megawatts for a few minutes, and they may lead to power densities of at least 250 kw/ft³. 14 pp. Illus. Presented before the American Rocket Society at Los Angeles, California, May 9-12, 1960.

● **P-1945. Development of man-machine simulation techniques.** M. A. Geisler. 3-17-60.
Unclassified.

A description of some of the features that favor the use of man-machine simulation in systems analysis that deals with problems in which the management control process of the system under study can significantly affect the system's cost or effectiveness. In this sense, the management control process is one of the alternative uses to which a system's resources can be allocated to produce a high level of system performance. It is shown that using man explicitly in the model of the system produces more valid results. Logistics systems fall into this category of systems analysis because they consist largely in management control processes, requiring policies, information systems, and organizational structures to be defined. An illustration of a man-machine simulation study from logistics is also given. 18 pp. Illus. Presented before the joint meeting of The Institute of Management Sciences and the Operations Research Society of America at the U.S. Naval Postgraduate School, Monterey, California, April 7-8, 1960.

P-1946. On programming a highly parallel machine to be an intelligent technician.
Allen Newell. 4-1-60. Unclassified.

Speculation on how to program a machine that is suitable for construction with microelectronic components to be an intelligent technician. The study is based on a class of machines described by J. H. Holland. These machines consist of a regular lattice of active modules, each possessing both processing and memory functions. The goal is a machine with the problem-solving capabilities of a smart human technical assistant, and with the volume-processing capabilities normally associated with digital computers. The basic organization for information processing is considered, together with the organization for problem solving, supervision, interpretation, and production. 43 pp. Illus. Presented before the Western Joint Computer Conference at San Francisco, California, May 3-5, 1960, and published in the proceedings of the Conference.

P-1947. A network flow computation for project cost curves. D. R. Fulkerson.
3-18-60. Unclassified.

A network-flow method for solving the linear-programming problem of computing the least-cost curve for a project composed of many individual jobs, where it is assumed that certain jobs must be finished before others can be started. Each job has an associated crash completion time and a normal completion time, and the cost of doing the job varies linearly between these extreme times. Assuming that the entire project must be completed in a prescribed time interval, the author attempts to find job times that minimize the total project cost. The method solves this problem for all feasible time intervals. 26 pp. Illus. Published in *Management Science*, January 1961.

P-1948. On control of linear systems with time lags. J. D. R. Kramer, Jr. 3-22-60.
Unclassified.

A discussion of the optimal control of linear systems with time lags, using the optimization technique of dynamic programming. The results are generally valid for any time-invariant linear system, and application to linear time-varying systems is immediate. 42 pp. See also P-1610. Published in *Information and Control*, December 1960.

• **P-1950. The Chinese People's Republic and the bomb.** Arnold Kramish. 3-23-60.
Unclassified.

An attempt to determine when China might obtain an independent atomic bomb capability. The research reactor purchased by the Chinese People's Republic from the Soviet Union became operative in mid-1958 and is presently China's only nuclear reactor. 7 pp.

P-1951. Weapons effects for protective design. H. L. Brode. 3-31-60. Unclassified.

Data on the nature of the violent forces with which protective designs must cope. Large-yield weapons used against hardened installations create an environment of air and ground shock and of thermal and nuclear radiations in extremes which military systems designers have only recently had to consider. As the hardening requirements rise, and systems are designed to survive closer in, the explosion phenomena of significance become those associated with a region of intensities of effects beyond present experience and understanding. These close-in phenomena are examined to delineate their influence on the survivability of structures and equipment at very high overpressure levels. No specific military system or components are considered. 69 pp. Illus. Incorporated in *Ground Support Systems for Missiles and Space Vehicles*, ed. by K. Brown and P. B. Weiser, published by McGraw-Hill Book Company, Inc., New York, 1961. \$15.00. Presented before the Space Technology Laboratories Colloquium at El Segundo, California, March 31, 1960. Also presented at the UCLA Extension Course on Ground Support Systems for Missiles and Space Vehicles, April 25-30, 1960.

P-1952. Dissipation functions and invariant imbedding—I. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 4-22-60. Unclassified.

An extension of previous research on the theory of invariant imbedding, used to derive a variety of nonlinear functional equations for describing radiative transfer, neutron transport, diffusion and heat conduction, scattering and random walk, and wave propagation. This paper presents a new method for establishing the existence of solutions of these equations in cases in which the creation of matter is not involved. The method is based on the introduction of a new class of physically important functions, the dissipation functions. By combining these new functions with the functions used in the past (the reflection and transmission functions), a basic conservation relation is

obtained. The uniqueness proofs follow conventional lines. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, August 1960.

P-1953. Sinkiang and Sino-Soviet relations. A. S. Whiting. 4-4-60. Unclassified. Data on Sinkiang, a Chinese province bordering on Soviet Central Asia. Sinkiang is discussed within the framework of Chinese and non-Chinese relations in the People's Republic, within the framework of Sino-Soviet relations, and within the larger expanse of cultural interaction in Inner Asia. The author reviews different periods in which the Soviet system has influenced developments in Sinkiang and examines, generally, the consequences of communism in Russia and China for the traditional societies of Central Asia. 20 pp. Published in *The China Quarterly*, July-September 1960.

- **P-1954. The Russian literature on rocket propellants.** F. J. Krieger. 3-25-60. Unclassified.

A paper presented before the 137th National Meeting of the American Chemical Society at Cleveland, Ohio, April 8, 1960. The Soviets publish the results of their scientific investigations in the popular press, as well as in a multiplicity of scientific and industrial journals. Although they publish widely on combustion, detonation, explosion, and industrial explosives, Soviet output of original material on rocket propellants is seriously limited by security restrictions. Nevertheless, examination of the Russian literature reveals (1) a thorough familiarity with Western developments and (2) considerable research activity on both solid and liquid propellants of the conventional and nonconventional variety. Among the propellants of special interest are pentaborane, ammonium nitrate, ozone, hydrogen superoxide, and frozen radicals. 25 pp.

P-1955. On the choice of objectives in systems studies. C. J. Hitch. 3-30-60. Unclassified.

A discourse on broadening our horizons and ambitions when objectives for systems studies are chosen. In the hierarchy of ends and means, there is no essential difference among levels, or between means and ends. The systems analyst may make contributions at high as well as low levels and may frequently be unable to contribute at low levels unless he contributes also at high levels. The objectives that the systems analyst strives to maximize must be clarified and defined. This is possible only if he is unconstrained by dogma and by false hopes for authoritarian or external solutions. 13 pp. Presented before the Systems Symposium at Cleveland, Ohio, April 26-28, 1960, and published in the proceedings of the Symposium.

P-1956. "Nth countries" and disarmament. F. C. Iklé. 4-1-60. Unclassified.

Counterarguments to the thesis that high priority be assigned to controls against the "Nth countries" because (1) the diffusion of nuclear capabilities presents one of the greatest dangers, (2) stopping this diffusion is now feasible, and (3) controlling it later will become increasingly difficult or impossible. As each of these arguments is qualified by a number of counterarguments, it becomes more doubtful whether "Nth country" controls must figure so prominently in disarmament policies. However, these counterarguments do not imply that the possible dangers from "Nth countries" are unimportant. 18 pp. Published in the *Bulletin of the Atomic Scientists*, December 1960.

P-1957. Note on the direction of high auroral arcs. E. H. Vestine. 4-4-60. Unclassified.

Proposed explanations for the orientation of auroral arcs. Possible relationships between several kinds of auroral phenomena are explored: between auroral pulsations and geomagnetic micropulsations, between the spread and direction of auroral arcs and the magnetic field gradients of polar electrojets, and between certain auroral displays and the Van Allen belts. 26 pp. Illus. Published in *Journal of Geophysical Research*, October 1960.

P-1959. Uncertainties in operations research. C. J. Hitch. 4-25-60. Unclassified.

A discussion of the uncertainties faced by operations researchers in determining a preferred strategy. The job of the operations researcher is to find, or invent, within the constraints, some better pattern of adjusting to an uncertain world, or by taking costs and payoffs into account, to buy information to reduce the uncertainty. The author is skeptical of general-purpose solutions to the problems of making good decisions for uncertain contingencies. He indicates that a shift is necessary from searching for the best way to choose between two contingently unsatisfactory answers to searching for a better answer. The uncertainties involved in military problems have their counterparts and analogues in business and in everyday life. 13 pp. Published in *Operations Research*, July-August, 1960. Presented before the Operations Research Society of America at New York, May 19-26, 1960.

P-1960. Some electrostatic cloud-droplet collision efficiencies. J. D. Sartor. 4-4-60. Unclassified.

A comparison of the collision efficiencies of cloud droplets, with and without a uniform electrostatic field. Recent electrostatic and hydrodynamic solutions to the two-body problem of the forces on neighboring spheres are combined to obtain the motion of cloud droplets. It is concluded that fields commonly observed in clouds can play an important role in the collision and in the coalescence of the droplets. 15 pp. Illus. Published in *Journal of Geophysical Research*, July 1960.

● **P-1961-RC. Long-range considerations in data processing for state and local governments. J. A. Postley. 4-6-60. Unclassified.**

An attempt to indicate the major impact of future applications of data processing in state and local government and some of the developments that foretell this impact. It is expected that developments of information recognition, information processing, information storage, and information retrieval will increase rapidly through the next decade. The primary impact of future data processing will be a modification of traditional organizational concepts in favor of a more explicit account of data-processing factors. 6 pp. Presented before the National Conference of the American Society for Public Administration, held at the University of Southern California, Los Angeles, California, April 12-14, 1960.

● **P-1962. Automatic content analysis: some entries for a transformation catalog. D. G. Hays. 4-8-60. Unclassified.**

A system for automatic content analysis that includes (1) a sentence-structure determination, or parsing, routine, (2) a routine for linguistic simplification, and (3) a routine for transformation from linguistic to sociological variables. This paper reviews the first two steps, illustrates the information requirements of the third step, and discusses alternative measurement techniques in content analysis as potential bases for automatization. 21 pp. Presented before the Western Sociological Association at Spokane, Washington, April 28-30, 1960.

P-1963. Meteoroids versus space vehicles. R. L. Bjork. 4-4-60. Unclassified.

A discussion of the effects that meteoroids are expected to have on space vehicles. Current knowledge of meteoroid flux rate, mass, velocity, density, and impact effects is summarized. The preliminary designs of space power-station radiators, as well as the examples given, indicate that the weight penalty imposed by estimates of the meteoroid hazard is large enough to warrant research on its reduction. Several promising areas of research that may lead to lighter-weight designs are investigated. 20 pp. See condensation P-2172. Published in the *ARS Journal*, June 1961. Presented before the American Rocket Society at Los Angeles, California, May 9-12, 1960.

P-1964. Reduction of dimensionality, dynamic programming, and control processes. R. E. Bellman and R. E. Kalaba. 6-3-60. Unclassified.

A discussion of the occurrence of processes having state vectors of high dimension, a major difficulty in achieving a successful systematic approach to the study of control processes by means of dynamic-programming theory. However difficult the problem is for systems ruled by a finite set of differential equations, it is several orders of magnitude more complex for systems of infinite dimensionality and for systems with time lags. By combining a technique for dealing with finite-dimensional systems and various methods of successive approximations and quasilinearization, certain classes of control processes associated with infinite dimensional systems can be treated. The ideas are illustrated by examining not only the control of a system involving a time lag, but also the control of a thermal system. 12 pp. Published in the *Journal of Basic Engineering*, March 1961.

● **P-1965. Deterrence of unlimited war: a propositional outline. Myron Rush. 4-11-60. Unclassified.**

An outline of the basic elements in the deterrence of unlimited war. A bipolar world is assumed in which one superpower deters the other from attacking it with nuclear weapons (unlimited war) by threatening nuclear retaliation. Considered are such implications as the effect of a first strike on the stability of deterrence, the effect of changes in delivery systems on the premium on the first strike, the effect of the likelihood of achieving a requisite degree of surprise in a first strike on ultimate deterrence, factors bearing on a decision to retaliate, and deliberations on launching a surprise offensive. 23 pp.

- **P-1966. An ergodic theorem.** R. E. Bellman. 4-11-60. Unclassified.

An attempt to indicate how a simple lemma due originally to Fekete, and in generalized form to Polya-Szego, permits a simple derivation of some interesting ergodic theorems. 7 pp.

- **P-1967. Cryogenic gyros.** W. H. Culver and M. H. Davis. 2-5-60. Unclassified.

A discussion of some practical aspects of superconducting gyros. The paper indicates the direction and type of research and development effort still needed to make performing gyros possible. 9 pp. Illus. Presented before the Professional Group on Military Electronics of the Institute of Radio Engineers at Los Angeles, California, February 5, 1960.

- **P-1968. A computer program for first-order-error propagation in satellite-orbit prediction.** Peter Swerling. 4-13-60. Unclassified.

A program written for the IBM 704 that computes the first-order errors in estimates of satellite orbital parameters as a function of observational errors. Some inputs of the program are as follows: a specification of an arbitrary observation network and earth-satellite orbit, a description of the errors in each type of observation for each observation site, and a data-smoothing method from a fairly broad class of possible smoothing methods. The output consists of the first-order errors in predicting satellite position and velocity components at any specified time. These may be described either statistically or nonstatistically. 11 pp. Published in the *Proceedings of the Seminar on Tracking Programs and Orbit Determination*, February 1960.

- **P-1969. Analysis of possible Lunik III picture hoax.** M. E. Davies. 4-1-60. Unclassified.

An examination of a recent article by Lloyd Mallan in *Popular Photography* purporting to show that the photographs of the back side of the moon taken by Lunik III are a hoax. 7 pp. See also P-1671 and P-1892. Published in *Astronautics*, June, 1960, and in *U.S. Camera*, August, 1960.

- **P-1970. Problems and concepts of general planetology.** S. H. Dole. 4-15-60. Unclassified.

An introduction of the concept of treating planets as members of a general class of non-self-luminous objects. Planets are shown to occupy the mass range roughly between 10^{-5} to 10^{-4} earth masses (10^{23} to 10^{32} grams). Objects above this mass range are stars, and below this mass range are meteoroids or asteroids. Planets are also classified into such types as airless bodies, planets with light atmospheres, and planets with massive atmospheres. The type is dependent on surface escape velocity and exosphere temperature. Some relationships among fundamental properties of planets are discussed, and some unresolved problem areas of general planetology are indicated. 35 pp. Illus.

- **P-1971. A note on stability, and the behavior assumptions of Harrod-type models.** R. R. Nelson. 4-20-60. Unclassified.

An examination of some implications of introducing into the desired investment equation of a Harrod-Domar model a term relating to the existing state of capital shortage or surplus. It is shown (1) that Rose's amended model is marked by great instability, but after some perturbations the economy can return to equilibrium and (2) that an economy described by the model is capable of rather lengthy periods of full employment growth at the top of a boom. Rose's analysis is a significant contribution to understanding problems not only of instability in Harrod-type models, but also of instability in the real world. 23 pp. Illus. Published in *The Economic Journal*, June 1961.

- **P-1972. A preliminary computation of pressure and temperature between 100 and 800 kilometers.** William Viezee. 4-18-60. Unclassified.

A presentation of preliminary pressure and temperature data on the atmosphere between altitudes of 100 and 800 km. Data on the density of the atmosphere taken from several sources serve as a basis for deriving mean pressure and temperature. The accuracy of the latter depends on the estimate of molecular weights of the gas mixture at high altitudes. Departures from this mean are caused by geophysical effects originating in solar emanations. 21 pp. Illus.

- **P-1973. Dynamic programming, sequential estimation, and sequential detection processes.** R. E. Bellman, R. E. Kalaba, and D. Middleton. 4-20-60. Unclassified.

A study of some general sequential-estimation and sequential-detection processes, provided with an analytical formulation through use of the functional-equation technique of dynamic programming.

Some reductions useful from the computational viewpoint are indicated, and several applications to radar and communication-system theory are shown. 7 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, March 1961.

P-1974. The effect of filamentary materials on pressure-vessel design. G. A. Hoffman.
4-19-60. Unclassified.

An analysis of the many useful pressure-vessel shapes to be derived for fiber-composite materials, and an estimation of the strength potential of "whiskers." Filamentary materials will afford the greatest weight reduction in future pressure vessels, possibly one-fifth to one-eighth of their present weight. They are already competitive and show some slight advantages over metal vessels. The worth of such future materials appears to be greater than their cost by a large factor. 21 pp. Illus. Presented before the Eleventh International Astronautical Congress at Stockholm, Sweden, August 15-20, 1960, and published in the proceedings of the Congress.

P-1975. Economic aspects of developing and orbiting a space station. M. A. Margolis.
4-20-60. Unclassified.

A discussion of the funding for the development and orbiting of a manned transfer space station. The paper examines the economy's capability to support higher budgets in connection with this program. Because of the uncertainty involved in orbiting a station, other criteria besides apparent minimum cost must be considered in selecting preferred alternatives (for example, the approach using the least new and untried equipment, the approach using components currently scheduled for development as part of other space programs with which development costs and test experience may be shared, and the approach that seems most promising as far as the earliest available space platform is concerned). 9 pp. Published in *Aerospace Engineering*, May 1960. Presented before the National Symposium on Manned Space Stations at Los Angeles, California, April 20-22, 1960.

P-1976. The far-field back-scattering from a concave corner of a body of revolution.
J. L. Raymond. 4-21-60. Unclassified.

A calculation of the monostatic head-on radar cross section formed by a concave ring singularity in the limit of small wavelengths. The solution is based on Oberhettinger's treatment of the diffraction of plane waves by an infinite wedge. The techniques of solution are chiefly those developed by Siegel when he derived the cross section of a convex ring singularity. The present solution completes the theoretical small-wavelength treatment for wedges of all angles. 19 pp. Illus. Presented before the Symposium on Echoing Properties of Missiles at Farnborough, England, June 8-9, 1960, and published in the proceedings of the Symposium.

P-1977. Geomagnetic control of the Van Allen radiation belts. E. H. Vestine. 4-21-60. Unclassified.

An explanation of the role played by the earth's geomagnetic field and the polar electrojets in trapping and releasing the charged particles in the Van Allen radiation belts. 21 pp. Illus. Published in the *Annals of the New York Academy of Sciences*, October 5, 1961. Presented before the New York Academy of Sciences at New York, January 20, 1961.

- **P-1978. Governors of the conjunction ΥTO .** J. H. Pustula. 2-22-60. Unclassified.
A list of all the words and idioms that have been found to govern ΥTO -clauses in the RAND corpora of Russian physics text. The Russian subordinate conjunction ΥTO (equaling *that*) introduces noun clauses. 16 pp. Tables.

P-1979. An approximate investigation of the effect of boundary layer control pumping on powerplant performance. T. F. Kirkwood. 4-25-60. Unclassified.

An analysis of the effects of boundary-layer bleed pumping on the performance of turbojet and turboprop powerplants. It is shown that turboprop engines suffer a greater loss due to pumping than do turbojet engines, particularly at low-flight speeds. This indicates that the performance of turboprop-powered airplanes using boundary-layer control is more sensitive to the efficiency of the duct and pumping system than is the performance of jet-powered airplanes. At low-flight speeds, duct loss tends to be the largest contributor to the suction drag coefficient. As flight speed is increased, pressure and momentum losses become more important. On low-speed turboprop airplanes, care should be taken in designing the ducting. 6 pp. Illus. Published in the *Journal of the Aerospace Sciences*, October 1960.

P-1980. A comparative study of prediction techniques. B. B. Brown. 4-29-60. Unclassified.

Some promising methods for improving predictive techniques used in estimating future demands of aircraft spare parts. As emphasis is on the improvement of demand estimates per program element, the study is based on the transactions of B-52 parts consumption from two bases for a period of 33 months. Only Hi-Valu and Category II parts are considered. It is indicated that about 25 per cent of the sample parts showed zero demand through 21 months of data. Other conclusions are drawn as to preferred techniques for particular parts. 30 pp. Tables. Published in the *Naval Research Logistics Quarterly*, December 1960. Presented before the Decennial Logistics Research Conference at George Washington University, Washington, D.C., January 20-22, 1960.

• **P-1981. Support resources.** E. W. Pickrel. 5-10-60. Unclassified.

An attempt to determine how many of what kinds of resources are needed where and when to support a missile or a man-machine system. Attack in the missile era will afford little or no opportunity for corrective maintenance. Malfunctions are missile losses (a requirement for a high reliability system). Corrective actions must be rapid (i.e., a remove-and-replace maintenance policy). The cost of reserve or support items is high. Their rate of demand is low and not completely predictable. These resources are now controlled on a system basis, with a resultant reduction in inventory. A support resource placement criterion for force depletion tasks is system utilization. A support resource placement criterion for deferrable tasks is resource utilization. An objective for today's support problem is increased efficiency and stable long-term support for creation of systems. 38 pp. Illus. Presented as a lecture in the course "Ground Support Systems for Missiles and Space Vehicles," given at the University of California at Los Angeles, June 13-18, 1960.

P-1982. Economic development, research and development, policymaking: some converging views. A. O. Hirschman and C. E. Lindblom. 5-4-60. Unclassified.

An examination of the convergence between the views of Albert Hirschman on economic development, Burton Klein and William Meckling on technological research and development, and Charles Lindblom on policymaking in general. These three independent lines of work appear to challenge, in remarkably similar ways, some widely accepted generalizations about what is variously described in the literature as the process of problem solving and decisionmaking. 28 pp. Illus. Published in *Behavioral Sciences*, April 1962.

P-1983. Model of error burst structure in data transmission. Pierre Mertz. 5-5-60. Unclassified.

A model of error distributions in data-transmission circuits that assumes a distribution of burst durations that follows recent experimental data. The distribution is bi-modal, and consists of a proportion of 1-bit bursts superimposed on a triangular continuous distribution. Earlier models made oversimplified assumptions about these distributions and based them on bursts of equal duration. 28 pp. Tables. Presented before the Data Transmission Session of the American Institute of Electrical Engineers at Chicago, Illinois, October 10-12, 1960, and published in the proceedings of the Meeting.

P-1984. Basic principles and technical variations in sentence-structure determination. D. G. Hays. 5-9-60. Unclassified.

A comparison of alternative methods of sentence-structure determination which can use one method as a base and shows the changes required to convert it into another. Basic principles of the RAND method include the isolation of grammatic detail from the structure of the computer program and the postulation of a certain word-order rule. Technical variations in the order of establishment of connections and in the procedure used for testing agreement make the RAND method more similar to others now in use and improve its accuracy. Restructuring and the use of context are noted as additional types of variation. 22 pp. Illus. Presented before the Fourth London Symposium on Information Theory at London, England, August 29-September 2, 1960, and published in the proceedings of the Symposium.

P-1985. Neutron branching processes. T. W. Mullikin. 12-20-60. Unclassified.

A study of the neutron population in a nuclear reactor as a branching process. New results are presented on the extinction probability of a supercritical reactor near the critical dimension, extending results of T. E. Harris. In this special context, parts of the theory of branching processes are given. The results apply to spheres, to infinite slabs, and to rods, with the assumptions that

the neutron energy is constant and that the collision-fission process is isotropic. Homogeneity is also assumed, although similar results can be obtained in nonhomogeneous cases of restricted types. Thus, a new computational method is determined for estimating the critical dimension and the steady-state flux for the reactors considered. This replaces the eigenvalue problem of transport theory by a nonlinear functional equation that can be solved by iteration. 33 pp. Also published as RM-2693. Published in the *Journal of Mathematical Analysis and Applications*, December 1961. Presented before the Bettis Division, Westinghouse, at Pittsburgh, Pennsylvania, June 9, 1960. Also presented before the Meeting on Math Analyses of Atomic Energy Operations at Germantown, Maryland, December 2, 1960.

P-1987. Why are the Chinese nervous? A. M. Halpern. 7-5-60. Unclassified.

A description of the development by Chinese Communist leaders (between October 1, 1959, and April 1, 1960) of an analysis of, and a declared policy concerning, the current international situation. Particular reference is made to the prospects for peaceful coexistence. Chinese Communist conditional acceptance of a role in disarmament negotiations is analyzed in this context. Areas of difference between the Soviet and Chinese Communist positions are identified, and an estimate is made of their significance. 26 pp. Published as "Communist China and Peaceful Co-existence" in *The China Quarterly*, July-September 1960.

P-1988. An analysis of the decisionmaking functions of a simulated air-defense direction center. A. F. M. Sweetland and W. W. Haythorn. 9-20-60. Unclassified.

An analysis of a complex data-processing decisionmaking system to determine how it responds in meeting its charged responsibilities. A simple dichotomous decision model, analogous to a manual air-defense direction center and descriptive of the system behavior, is constructed. 26 pp. Illus. Published in *Behavioral Science*, April 1960. Presented before the Western Electronic Show and Convention at Los Angeles, California, August 23-26, 1960.

- **P-1989. A digital simulation of an aided adaptive character reading machine.** P. Baran and G. Estrin. 5-17-60. Unclassified.

A simulation, on an IBM 709 computer, of a pattern-recognition system using an initial man-machine learning phase. Transformations on a deformed set of 48 samples of each of ten numerals are used to form separation filters, while a second set of 480 similarly varied numerals serve as the "unknown" characters that are examined. Measured probability density distributions of the inked areas of all characters are established, and a weighted stencil or filter is created to distinguish each character relative to the possible set of characters. This experiment demonstrates the extent to which the actual value of the best "score of match" between the unknown and each character in the set provides confidence in recognition. Whenever the best score is too low, it is possible to call for more complex processes to aid recognition permitting the construction of recognition systems of greater accuracy than the basic reading mechanism. 26 pp. Illus. Presented before the Western Electronic Show and Convention at Los Angeles, California, August 23-26, 1960.

- **P-1990. An aided adaptive character reader for machine translation of languages.** P. Baran and G. Estrin. 5-17-60. Unclassified.

A description of an elementary procedure for the synthesis of a character-recognition device based on a learning experiment. Using information derived from a significant sample of the set of characters to be read and given identification of the samples by a human operator, a computer defines a set of "filters." These filters may then be used to transform unknown characters having similar type characteristics. During the recognition process a probability matrix for each character in the alphabet is used to compute a figure of merit for the hypothesis that an unknown character is the same as a known character. It is shown that this elementary model may aid in constructing a fast input device for a language translation machine if it was able to make use of frequency distribution characteristics of the dictionary. A possible implementation with a raw character reading rate up to 500 characters a second appears feasible. 45 pp. Illus. Presented before the Western Electronic Show and Convention at Los Angeles, California, August 23-26, 1960.

P-1991. A mathematical formulation of variational processes of adaptive type. R. E. Bellman. 5-19-60. Unclassified.

A study that shows how the functional equation technique of dynamic programming can be used to treat adaptive control processes and how continuous processes can be defined in terms of the

discrete versions. 26 pp. Presented before the Fourth Berkeley Symposium on Mathematical Statistics and Probability at the University of California at Berkeley, June 20–24, 1960, and published in the proceedings of the Symposium.

P-1992. Limits for stable near-circular planetary or satellite orbits in the restricted three-body problem. S. H. Dole. 5-18-60. Unclassified.

Expressions for calculating the limiting radii of the regions where stable near-circular orbits can exist. These expressions are developed from Jacobi's integral to the equations of motion of a particle. Computed quantitative values for these radii are given in graphical and tabular form for mass ratios from 10^{-8} to 0.5. An example is given of the application of these limits to an idealized earth-moon system (mass ratio, 0.012128563). 23 pp. Illus. Published in the *ARS Journal*, February 1961.

P-1993. A heuristic program for assembly-line balancing. F. M. Tonge. 5-18-60. Unclassified.

An application of heuristic procedures to solve the assembly-line-balancing problem. Assembly-line balancing is defined as a process of assigning jobs to workers stationed along a continuous assembly line. The author attempts (1) to develop an acceptable, though not necessarily optimum, procedure for assembly-line balancing and (2) to discuss the use of computers for implementing heuristic decision procedures in the industrial management area. It is concluded that the combination of a heuristic approach and methods of computer use considered is advantageous in treating complex industrial management problems. 159 pp. Illus. Published as *Heuristic Program for Assembly Line Balancing*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1961. \$4.50.

● **P-1994. Tentative generalization of leading-edge viscous interaction phenomena. A. F. Charwat. 3-15-60. Unclassified.**

An isobar map of the leading-edge interaction problem in the domain of three independent variables: interaction parameter, rarefaction parameter, and wall-temperature ratio. This representation not only provides a framework within which to study further leading-edge interaction phenomena, but also discloses contradictions and insufficiencies in the currently available data. 21 pp. Illus. Presented before the Second International Symposium on Rarefied Gas Dynamics at the University of California at Berkeley, August 3, 1960.

● **P-1995. Reliable digital communications systems using unreliable network repeater nodes. Paul Baran. 5-27-60. Unclassified.**

A description of a communications network that uses a moderate degree of redundancy to provide high immunity from the deleterious effects of damage of relay centers. The degree of redundancy needed is shown to be determined primarily by the amount of damage expected. Curves indicating the optimum degree of redundancy are shown, and the distribution of performance under different damage patterns is discussed. The redundancy desired is shown to vary as a function of the station position in the network, the stations at the fringe of the network requiring more redundancy than the inside stations. 27 pp. Illus. Presented before the IRE Sixth National Communications Symposium at Utica, New York, October 3–5, 1960.

● **P-1996. Optimal inventory policy for serviceable and repairable stocks. E. S. Phelps, Jr. 6-21-60. Unclassified.**

An investigation of the structure of the optimal policy toward serviceable and repairable stocks of a spare part to be followed by a supplier. It is assumed that the supplier is confronted periodically with a random number of orders for serviceable parts and periodically has the opportunity to increase or decrease his stocks through the procurement or disposal of serviceables and the repair and disposal of repairables. This policy structure describes qualitatively the actions (procurement, repair, and disposal of serviceables and repairables) that should be taken for every initial state, namely, the state being described in terms of the serviceable and repairable stocks on hand. 55 pp. Illus.

P-1997. Optimizing a prelaunch checkout. S. I. Firstman and B. J. Voosen. 6-22-60. Unclassified.

A consideration of the problem of making design decisions for time-limited checkouts of ballistic missiles. The paper develops (1) a quantitative criteria for the value of including individual checks in the checkout, (2) an expression for the required efficiency of the checkout equipment, and (3) a mathematical method for determining the content of a theoretically optimum checkout. An example is

given. The method developed can also be used to ascertain the launch confidence of existing systems. 23 pp. Illus. Presented before the Third Electronic Industries Association Conference on Maintainability of Electronic Equipment at San Antonio, Texas, December 7, 1960, and published in the proceedings of the Conference.

P-1999. On university courses in materials for the engineer. W. R. Micks. 6-8-60. Unclassified.

A discussion of certain factors relevant to the character and content of university courses in materials for the undergraduate engineer. These factors include the desirability of fundamentals versus specialization, the emphasizing of materials behavior rather than materials properties, the influence of the systems approach in engineering design, and the implications of the basic methodology of engineering synthesis as the primary engineering function affording progress. 12 pp. Published in *The Journal of Engineering Education*, March 1961. Presented before the American Society for Engineering Education at Purdue University, Lafayette, Indiana, June 20-24, 1960.

P-2000. The violation of arms control agreements: deterrence vs. detection. F. C. Iklé. 8-1-60. Unclassified.

An examination of the likelihood that a potential violator of an arms control agreement will not be deterred by the risk of detection unless he fears that his gains from an evasion will be outweighed by unfavorable consequences. To determine the consequences of a detected evasion, this study discusses (1) the effect of a reaction by world opinion, (2) the political reaction of the injured country, (3) the military measures undertaken by the injured country to restore the situation that would have existed without an arms-control agreement, and (4) the military and political measures that go beyond this "restoration." 13 pp. Published in *Foreign Affairs*, January 1961.

● **P-2001. Toward a new system for allocating the cost of capacity.** E. B. Berman. 5-27-60. Unclassified.

A presentation of a new concept of capacity cost. In this system a requirement for an additional unit of capacity does not lead either to no cost if the unit is already available or to the full cost of building an additional unit if it is not already available. The former event implies a cost because it advances the time when it is expected that an additional unit of capacity be constructed. The latter event offers a savings to offset the full cost of constructing a unit of capacity in the form of a probability that the unit now constructed would have been needed for the next generation anyway. 14 pp. Illus. Presented before the Joint Study Group on Resource Allocation Methodology at Menlo Park, California, May 23-25, 1960.

P-2002. Effect of geometrical libration on the damped motion of an earth satellite. L. N. Rowell and M. C. Smith. 6-15-60. Unclassified.

The mathematics of damping the geometrical libration of a satellite. This paper considers the outputs of two sensing devices (the rate gyro and the horizon scanner). It is shown that neither used alone can fully compensate for significant orbital eccentricity, but that used together they relax the need for stringent orbital control. 12 pp. Published in the *ARS Journal*, March 1961. Presented before the Eleventh International Astronautical Congress at Stockholm, Sweden, August 15-20, 1960.

P-2003. Temperature and circulation of the Venus atmosphere. Yale Mintz. 5-27-60. Unclassified.

A study of temperature and circulation of the Venus atmosphere. The atmosphere above the planet's visible surface appears convectively stable. The visible surface has a mean temperature near 237°K and may be a thin hydrocarbon smog masking a planet-side hydrocarbon sea. Visible and ultraviolet markings suggest a cellular atmospheric circulation underlying a circumpolar zonal flow. 27 pp. Illus. Published in *Planetary and Space Science*, June 1961.

P-2004-1. Impact wave propagation in columns of sand. B. R. Parkin. 1-11-61. Unclassified.

The development of a phenomenological theory to study the propagation of unidimensional compression waves in columns of sand. The medium of the theory is treated as an elastic-plastic continuum. It is assumed that each element of the substance exhibits a strain-rate effect such that, at a given strain, the plastic strain-rate is proportional to the difference between the compressive

stress on the particle and that stress which would act on the element under static conditions. Published experimental results on the propagation of stress waves in sand are used as a basis of comparison between experiment and theory. The present theory gives satisfactory agreement with experiments on two dry sands. In addition, the theory is used to investigate the response of drum-type pressure gauges to impact loading, and problems connected with the derivation of "dynamic" stress-strain curves from experimental stress histories at fixed points in a sand. Conditions derived from the theory that might permit the proper scaling of laboratory results are discussed. 85 pp. Illus. An abridgment of RM-2486. For Part II of this study, see P-2192. Published under the title, "Impact Waves in Sand: Theory Compared with Experiments on Sand Columns," in the *Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers*, June 1961.

P-2005. Soviet atomic energy. Arnold Kramish. 5-31-60. Unclassified.

A study of the Soviet atomic energy program since the late 1930's. By 1940 the Special Committee for the Problem of Uranium was established. A complex of scientific institutions has since evolved, with specialized tasks relating to the atomic energy program. The first Soviet atomic explosive device was tested on August 29, 1949, and the first hydrogen device on August 12, 1953. Nuclear weapons are now an integrated component of many sectors of Soviet armament. However, the advent of *Sputnik* has temporarily depreciated atomic energy as a major economic and psychological force, except in connection with bomb testing. 9 pp. Incorporated in the *Encyclopedia of Russia and the Soviet Union*, published by McGraw-Hill Book Company, New York, 1961. \$23.50.

● **P-2006. Economic planning and the military electronics industry. F. S. Pardee. 6-24-60. Unclassified.**

A discussion of the role of the economist (1) in making over-all evaluations of national economic conditions and corporate long-range planning activities, and (2) in using cost-sensitivity-analysis techniques to estimate the economic impact of alternative engineering designs, concepts of maintenance, logistics, training, and other operational deployment considerations. A decided challenge faces the engineer in evaluating the relative resource impact of alternative designs and the cost savings to be gained from improvements. The various disciplines must work together to realize sound system design and appropriate operational concept. 22 pp. Illus. Presented before the Institute of Radio Engineers, Professional Group on Military Electronics, at Los Angeles, California, November 23 and 24, 1959.

P-2007. Some consequences of local acceleration of auroral primaries. J. W. Chamberlain, J. W. Kern, and E. H. Vestine. 6-3-60. Unclassified.

A possible explanation of the origin of the polar electrojet. Approximate computations show that accelerated electrons derived from solar plasma could reasonably form a north-south electric field of sufficient strength to drive the observed westward current near the auroral zone. 7 pp. Published in *Journal of Geophysical Research*, August 1960.

● **P-2008. One-dimensional expansion of a finite mass of gas into vacuum. Carl Greifinger and J. D. Cole. 6-6-60. Unclassified.**

A paper showing that in the expansion into vacuum of a finite mass of gas, a solution of similarity form exists for large times. This asymptotic similarity is first extracted from an exact solution of the equations of motion for a perfect gas with $\gamma = \frac{7}{5}$, and is then derived from first principles for a perfect gas with arbitrary γ . The exponent of the similarity solution is determined from the existence of a limiting characteristic that coincides with a similarity line. The range of validity of the similarity solution is estimated by comparing the similar flow with the actual flow for $\gamma = \frac{7}{5}$. The solution is also interpreted as representing the flow of a plane hypersonic jet into vacuum. 36 pp.

● **P-2009. Time and civil defense. H. H. Mitchell, M.D. 6-7-60. Unclassified.**

A discussion of the importance of civil defense, which is examined from the viewpoint of historical time, present time, clock time, and calendar time. Such aspects of civil defense are considered as the preparations to limit the extent of damage the U.S. may suffer, Soviet civil-defense efforts, the feedback effect of civil defense on foreign policy and military decisions, and the preventive effect of civil defense in connection with medical problems in a postattack situation. 10 pp. Illus. Presented before the Conference of the U.S. Civil Defense Council at San Diego, California, May 25-27, 1960.

P-2010. Accelerating the cutting plane method for nonlinear programming. P. S. Wolfe. 4-3-61. Unclassified.

A discussion of the cutting plane method of Kelley for nonlinear programming problems. This method applies linear programming, through a sequence of local linearizations, to the problem of minimizing a convex function of real variables subject to linear inequality constraints. A procedure is presented for improving the constructed linearizations that may considerably accelerate the convergence of the process. In the case of a quadratic objective function satisfying certain mild conditions, this improvement yields a finite algorithm. 16 pp. Illus. Published in the *Journal of the Society for Industrial and Applied Mathematics*, September 1961.

P-2011. Some mathematical aspects of optimization problems in engineering. R. E. Kalaba. 6-6-60. Unclassified.

An application of the functional-equation technique of dynamic programming as a guide in the formulation and in the analytical and numerical treatment of chemical-engineering problems that involve multistage decision processes. Deterministic, stochastic, and adaptive decision processes are discussed. A method is given for treating classical variational problems as continuous decision processes, and techniques for reducing dimensionality are examined. 24 pp. Presented before the Symposium of Optimization Problems in Chemical Engineering, held at New York University, New York, May 18, 1960, and published in the proceedings of the Symposium.

P-2012. Electrical power from magnetohydrodynamic (MHD) generators. J. H. Huth. 6-10-60. Unclassified.

A discussion of the general characteristics, problems, and work in progress on magnetohydrodynamic electrical-power generators. It is concluded that these generators will initially find their main application as a source of short-duration large-power pulses. 13 pp. Illus. Incorporated in *Energy Conversion for Space Power Progress in Astronautics and Rocketry—Vol. III*, published by Academic Press, Inc., New York, 1961. \$7.25. Presented before the American Rocket Society Space Power Systems Conference at Santa Monica, California, September 27–30, 1960.

P-2013. On the computational solution of differential-difference equations. R. E. Bellman. 6-13-60. Unclassified.

A description of a way to reduce the solution of a certain form of high-dimensional vector system to the solution of a system of ordinary differential equations of degree dependent on the interval over which the solution is desired. In this way the memory requirements are reduced almost to zero. The need to examine the feasibility of computational solution of high-dimensional vector systems has arisen in connection with mathematical models of chemotherapy. 5 pp. Published in the *Journal of Mathematical Analysis and Applications*, February 1961.

P-2014. Invariant imbedding, conservation relations, and nonlinear equations with two-point boundary values. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 6-20-60. Unclassified.

A mathematical description of physical processes that yields linear and nonlinear functional equations with boundary value and initial value conditions. The boundary value aspects render the analytical discussion of existence and uniqueness of solutions rather complex and the computational solution even more difficult. The way has been previously shown in which many boundary value problems can be reduced to initial value problems and in which the theory of invariant imbedding can be used to provide conservation relations, which permits the bypassing of the spectral theory in the establishment of existence and uniqueness theorems. This paper considers transport processes in which collision effects introduce nonlinearities and indicates how conservation relations help to obtain existence theorems for nonlinear differential equations with two-point boundary values. 6 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September 1960.

P-2015. Ionization loss rates below 90 km. C. M. Crain. 6-15-60. Unclassified.

A survey of the current state of understanding of certain ionization phenomena in the normal atmosphere from ground level to about 90 km. The paper deals primarily with the various electron and ion decay rates and the concentration of charges resulting from given electron production rates. Simple, approximate expressions are derived for day and night quasi-equilibrium conditions, and comparisons are given for the relative effects of ionizing radiation during daytime and nighttime. 26 pp. Illus. Published in the *Journal of Geophysical Research*, April 1961.

P-2016. "Deterrence" and surprise attack in Soviet strategic thought. A. L. Horelick. 6-13-60. Unclassified.

An examination of evidence on how our opponents view deterrence in ensuring the survival of nuclear retaliatory forces against surprise attack and how closely their beliefs correspond to the assumptions made about them in the framing of Western deterrence strategy. The paper discusses some aspects of Soviet leaders' beliefs about deterrence and the related question of strategic surprise insofar as these beliefs are revealed in their public statements. In interpreting the statements of Soviet leaders, the author analyzes their rhetorical objectives, keeping in mind that their statements are designed as much to influence their external opponents and to disarm the criticisms of their internal rivals as to disclose their beliefs. 32 pp. Also published as RM-2618. Published in the *Royal Canadian Air Force Staff College Journal*, 1960.

P-2018. Wind systems in the mesosphere and lower ionosphere. E. S. Batten. 6-13-60. Unclassified.

A discussion of possible wind systems in the mesosphere and lower ionosphere. Recently, new wind data from 30- to 100-km altitudes have become available. Using these data, cross sections of zonal wind are constructed and compared with the existing model of the mesosphere and lower ionosphere. Temperatures at 60° N are then computed from the zonal winds, and when compared with observations at Fort Churchill, show good agreement for summer and large deviations for winter. 29 pp. Illus. Published in the *Journal of Meteorology*, June 1961.

P-2019. A note on the cause of sudden ionization anomalies in regions remote from high-altitude nuclear bursts. C. M. Crain and P. Tamarkin. 6-13-60. Unclassified.

A paper suggesting that certain very-low-frequency and higher-frequency propagation anomalies are caused by ionization from beta particles from the decay of detonation-produced neutrons resulting from high-altitude nuclear explosions. The study explains how this mechanism causes propagation anomalies over paths at great distances from the point of detonation that are shadowed by the earth from the detonation. 10 pp. Illus. Published in the *Journal of Geophysical Research*, January 1961.

● **P-2020. Appropriate roles and some limitations of man as a guidance component. H. H. Bailey. 6-14-60. Unclassified.**

A review of the circumstances and logical relationships that lead to requirements for terminal guidance in some cases, and for manned target search in others. The capabilities of a crew member for target search and identification are discussed in connection with his needs for adequate contrast, resolution, time, and prior knowledge. Simple quantitative statements of the first three of the requirements are included. 16 pp. Illus. Presented before the Institute of Aeronautical Sciences at San Diego, California, August 2, 1960.

● **P-2021. Weapon system cost sensitivity analysis as an aid in determining economic resource impact. F. S. Pardee. 6-15-60. Unclassified.**

A suggestion that cost sensitivity analysis be used to estimate the financial magnitude of alternative weapon system mixes, designs, test and operational concepts, and the time-phasing of these alternatives. This technique is only part of a full operations research or systems analysis effort, and to be useful it must be integrated into the over-all cost-effectiveness evaluation. Sound financial information thus furnished at an early point in time prior to the decision to commit on new major weapons can make the maximum contribution in minimizing the resource drain of military expenditures on the economy. 27 pp. Illus. Presented before the Fifth West Coast Classified Military Operations Research Symposium at San Diego, California, May 26 and 27, 1960.

P-2022. The Chinese genie: Peking's role in the nuclear test ban negotiations. A. L. Hsieh. 6-20-60. Unclassified.

A discussion of the role of Communist China in the disarmament negotiations. This paper examines (1) China's intention to manufacture atomic bombs, (2) Soviet support of China's participation in the test-ban negotiations, (3) China's reluctance to commit herself to an Asian atom-free zone, and (4) her announcement that she must have her say on all major international questions concerning her interests and that of world peace. China is prepared to use the concern over her exclusion from disarmament agreements to reinforce an image of herself as an independent entity with which both the United States and the Soviet Union must deal. Communist China has still not announced her

price for adherence to a disarmament pact, and the possibility should be recognized that China may not be willing to relinquish her atomic aspirations at any price. 26 pp. Also published as RM-2595. Published as "China, Russia, and the Bomb" in the *New Leader*, October 17, 1960.

P-2025-2. Facts and morals in the arms debate. R. A. Levine. 6-30-61. Unclassified.

An examination of the basic issues in the armament-disarmament debate. The agreements and disagreements on the issues involved are described from the standpoint of the participants' views concerning (1) certain physical facts, (2) the probability of certain future situations, given various possible present policies, and (3) moral-value judgments with which to weigh subjectively the possible effects of United States policy. The over-all goals relevant to the debate are peace and freedom for the world, the real difference being found in the relative weighting of these two goals. 27 pp. Presented before the Evanston World Affairs Council at Evanston, Illinois, January 22, 1961.

P-2026. The Chinese Communist line on neutralism. A. M. Halpern. 1-11-61. Unclassified.

Some hypotheses concerning the use of appeals to Asian neutralism as an element in Communist China's foreign policy. The hypotheses are limited to the period from November 1957 through May 1960. This political strategy is seen as one component of the general problem of exploiting a presumed position of strength and of weakening the U.S. military position in Asia. Fluctuations and inconsistencies in the Communist Chinese line are attributed to the ideological predispositions of the Communist Chinese leadership, to the conflict between China and Yugoslavia concerning active coexistence, and to the impact of trends and events in Asia disadvantageous to China's ambitions. 42 pp. See companion study RM-2657. Published in *The China Quarterly*, January-March 1961. Presented before the Third International Conference of Sovietologists and Sinologists at Tokyo, Japan, September 19-24, 1960.

P-2027. Angular accuracy of a phased array radar. L. E. Brennan. 10-22-59. Unclassified.

An approach to the theory of angle measurement with phased-array radars that use a set of separate antenna elements, each followed by an individual amplifier, in place of a more conventional receiving antenna. This study defines, for a phased array, the theoretical limit on angular accuracy that is set by receiver noise. It is shown that the accuracy of amplitude-comparison monopulse approaches this theoretical limit for large signal-to-noise ratios. The same accuracy can be achieved with phase-comparison monopulse by proper weighting of the individual signals. 30 pp. Illus. Also published as RM-2467. Published in *IRE Transactions on Antennas and Propagation*, May 1961.

P-2028. A duality theorem for nonlinear programming. P. S. Wolfe. 2-7-61. Unclassified.

A formulation of a dual problem for the mathematical-programming problem of minimizing a convex function under convex constraints that reduces to the classical dual problem in the case of linear-programming problems. Duality theorems are proved concerning the relationship between the problem and its dual. 15 pp. Table. Published in the *Quarterly of Applied Mathematics*, October 1961.

P-2029. Conflict resolution in the Sino-Soviet alliance. A. S. Whiting. 1-1-61. Unclassified.

Remarks focusing on the key variables which affect conflict resolution in the Moscow-Peking axis. Illustrative references are given supporting the inclusion of such factors as the need for consensus between Peking and Moscow, an image of negotiations to understand past phenomena and future developments, and the relations which Peking and Moscow enjoy respectively with communist parties outside the bloc. In the 1960's serious problems confronting coordination between Moscow and Peking will undoubtedly increase the tensions within the alliance. 33 pp. Presented before the Third International Conference of Sovietologists and Sinologists at Tokyo, Japan, September 19-24, 1960, and published in the proceedings of the Conference.

• **P-2030. On style in research and development.** A. H. Katz. 1-26-60. Unclassified.

A comparison—illustrated by reconnaissance systems but applicable to any research and development project—of optimum long-range systems and of crude, more immediately available ones. The author

evaluates the "style" of both, i.e., their merit and nature. He shows the advantages of a workable potential system over an ideal but overcomplicated system. 11 pp. Published in *Air Force and Space Digest*, February 1962.

P-2031-RC. The financing of public investment in Communist China. Feng-hwa Mah. 6-30-60. Unclassified.

An inquiry into the state capital investment in Communist China during the first Five Year Plan (1953-1957). The Chinese Communists have extracted funds to maintain a high investment level through a forced industrialization program. External sources for financing during this period were negligible, and development since 1956 has indicated that it is not likely that additional external funds will be forthcoming in the foreseeable future. Much of the domestic financing has been accomplished by the transfer of financial resources out of the agricultural sector. 53 pp. Tables. Published in *The Journal of Asian Studies*, November 1961. Presented before the Association for Asian Studies at New York, New York, April 11, 1960.

P-2032. Warming of the polar mesosphere and lower ionosphere in winter. W. W. Kellogg. 7-5-60. Unclassified.

A discussion of a mechanism that appears to maintain the relatively high temperature of the upper polar atmosphere in winter. Atomic oxygen dissociated in the mesosphere and lower ionosphere may be drawn downward in a widespread polar subsidence, or by other means. Evidence suggests that such a subsidence occurs after the onset of winter. In a descent of as little as 42 meters per day, the heat released in the recombination of the oxygen is sufficient to account for the predicted and observed temperatures. 26 pp. Illus. Published under the title, "Chemical Heating above the Polar Mesopause in Winter," in the *Journal of Meteorology*, June 1961.

P-2033. The convergence problem for differential games. W. H. Fleming. 7-14-60. Unclassified.

A discussion of the convergence problem for differential games that attempts to show that the value V_n of the n th game tends to a limit V as n tends to ∞ . Such aspects of the convergence problem are considered as games of prescribed duration, majorant and minorant games, time-continuous form, problems of pursuit type, and stochastic maximization problems. 25 pp. Published in the *Journal of Mathematical Analysis and Applications*, August 1961.

P-2035. Geomagnetism in relation to aeronomy. E. H. Vestine. 7-12-60. Unclassified.

A review of the status of certain features of geomagnetism as they affect aeronomy. Everyday features and more irregular fluctuation of the geomagnetic field appear to be caused in part by—and in turn to create some effect on—ionized particles in the atmosphere and by the Van Allen radiation belts and by certain auroral displays. 25 pp. Illus. Published in *Annales de Géophysique*, April-June 1961. Presented before the Symposium on Aeronomy, International Association of Geomagnetism and Aeronomy, International Union of Geodesy and Geophysics, at Copenhagen, Denmark, July 22, 1960.

● **P-2037. The commercial aircraft bomb hazard: a possible answer.** L. S. Hill. 7-13-60. Unclassified.

A proposed solution to the commercial aircraft bomb problem: that of dispersing luggage so that the passenger and his luggage will never be carried on the same airplane (or if so, not to the traveler's knowledge). This scheme may be considered an interim measure until air transports strengthened in vulnerable areas are available. The airlines will be benefited because delays and flight cancellations will be diminished. 5 pp.

● **P-2038. Low-acceleration transfer orbits.** Eugene Levin. 7-15-60. Unclassified.

A survey of the present status of low-acceleration powered-flight trajectory mechanics. 54 pp. Illus.

P-2039. On the solution of two-stage linear programs under uncertainty. G. B. Dantzig and A. Madansky. 7-28-60. Unclassified.

A paper showing that the concept of expected optimal prices for the second stage of linear programs plays an important role both in theory and in the constructive solution of such problems. 24 pp. Also published as RM-2751. Presented before the Fourth Berkeley Symposium on Mathematical Statistics and Probability at the University of California at Berkeley, June 20-24, 1960, and published in the proceedings of the Symposium.

P-2040. On the elementary approach to diophantine equations. O. A. Gross. 7-20-60. Unclassified.

A discussion of the use of elementary arguments either to supplement purely algebraic and/or analytic methods in the solution of equations in integers, or even to replace them when the elementary method appears superior. Various examples of the elementary approach are given. 18 pp. Published in *Mathematics Magazine*, May-June 1961.

P-2041. A local reduction of F-region ionization due to missile transit. H. G. Booker. 7-18-60. Unclassified.

An explanation of the behavior of the ionosphere upon penetration by the Vanguard II missile. Hot gases from the missile's exhaust causes a local diminution in the ionization density, forming a hole through the F region. Diffusion along the earth's magnetic field tends to realign the hole along the lines of flux. The hole fills up in about half an hour, principally by re-ionization under the influence of solar radiation. 16 pp. Illus. Published in the *Journal of Geophysical Research*, April 1961.

P-2042. A public opinion game. W. P. Davison. 7-25-60. Unclassified.

A suggestion that public opinion be simulated through the use of a "public opinion game." In such a game the players are arbitrarily assigned roles, and each player is asked to react to selected issues in a manner that he thinks is appropriate for his role. This game may serve (1) to indicate the degree to which initial private opinions are apt to change as a result of discussion, and the direction of this change, and (2) to enable more direct observations to be made about the interaction of pre-existing attitudes and interests, primary group pressures, and secondary group influences. 19 pp. Illus. Published in *The Public Opinion Quarterly*, Summer 1961. Presented before the American Association for Public Opinion Research at New York, New York, May 1960.

● **P-2043. The computational solution of variational problems.** S. E. Dreyfus. 8-1-60. Unclassified.

A paper that discusses the standard technique for the numerical solution of trajectory problems, indicates the difficulties that should be expected, proposes an alternative method, describes its shortcomings, and questions the current applicability of the variational approach to practical trajectory problems. 11 pp. Illus. Presented before the Mathematical Optimization Techniques Symposium at Santa Monica, California, October 18-20, 1960.

P-2044. Numerical investigations of chemotherapy models. Bella Kotkin. 9-6-61. Unclassified.

A description of a series of computational experiments designed to attack the solutions of a two-organ model in which a chemical reagent has been injected into the blood stream. The model investigated comprises twenty differential-difference equations, in which the capillary bed is replaced by a number of mixing chambers in series in contact with the extracellular space. Some results have already been obtained that agree with the steady state obtained from theoretical considerations. 36 pp. Illus. Presented before the Fourth International Conference on Medical Electronics (sponsored by the Institute of Radio Engineers) at New York, New York, July 16-21, 1961, and published in the digest of the Conference.

P-2045. The influence of Prandtl number on the heat transfer from rotating non-isothermal disks and cones. J. P. Hartnett and E. C. DeLand. 7-20-60. Unclassified.

Solutions of the energy equation for the rotating nonisothermal disk or cone with power-function surface-temperature distribution covering (1) a range of Prandtl numbers from 0.1 to 100 and (2) values of the exponent m from 0 to 10. 10 pp. Illus. Published in the *Journal of Heat Transfer*, February 1961.

P-2046. On the problem of ballistic missile defense. R. D. Holbrook and J. F. Gross. 7-25-60. Unclassified.

A discussion of technical problems relating to active defense against missiles. The authors question whether such a defense can be technically, economically, or operationally feasible. Some definitions are included, as well as information on the relationships between defenses and national attitudes. 24 pp. Illus. Published as "The Choice of Defense" in *Astronautics*, October 1960.

- **P-2047. Interactions of infrared radiation with the atmosphere: a guide to the modern literature.** Sidney Passman. 7-26-60. Unclassified.

An annotated bibliography on the interactions of infrared radiation with the atmosphere. Ninety-five recent references, arranged according to a logical division of atmospheric effects, are given. 31 pp. Presented before the University of California at Los Angeles course on Infrared Physics and Technology, August 2, 1960.

- P-2048. A mathematical model of the chemistry of the external respiratory system.** G. B. Dantzig, J. C. DeHaven, and C. F. Sams, M.D. 7-28-60. Unclassified.

A summary of the mathematical aspects of RM-2519, *A Mathematical Model of the Human External Respiratory System*. In particular, a mathematical model is described to represent the more important of the known interrelated physiological functions and chemical reactions involved in the human respiratory system. 33 pp. Illus. See also P-1811 and P-2139. Presented before the Fourth Berkeley Symposium on Mathematical Statistics and Probability at the University of California at Berkeley, June 20-24, 1960, and published in the proceedings of the Symposium.

- **P-2049. Low cost cargo aircraft: turboprop or turbofan?** T. F. Cartaino and R. B. Johnston. 9-7-60. Unclassified.

A re-examination of the state of the art in subsonic-cargo-aircraft design. It is shown that a selection between turboprop and turbofan cargo airplanes cannot be made on the basis of cost alone but depends on such factors as engine availability, the particular operating constraints encountered, and the personal preferences of the people involved in the system's operation. 19 pp. Illus. Presented before the National Aeronautic Meeting of the Society of Automotive Engineers, Inc., at Los Angeles, California, October 10-14, 1960.

- **P-2050. An example of man-machine simulation in logistics research.** J. D. Little and W. V. Shelton. 8-2-60. Unclassified.

A description of the computer applications and data-processing aspects of the operation of the Logistics Systems Laboratory, one of the major users of electronic data-processing installations at RAND. Background material is provided on the laboratory purpose, logistics operations, and man-machine simulation as a research tool. The current laboratory project, LP-III, is also described. The projects of the Logistics Systems Laboratory are a significant and worthwhile application of digital-computing techniques and resources. 19 pp. Presented before the Association for Computing Machinery National Meeting at Milwaukee, Wisconsin, August 25, 1960.

- **P-2051. Manpower planning for the space age.** M. C. Heuston. 8-5-60. Unclassified.

A study of the manpower implications of a proposed space system. The framework, which is developed in a total system context, includes such steps as developing a mission concept, developing environmental context, describing personnel-policy constraints, developing system functions, developing task groups, designing system organization, estimating workloads, and computing manpower requirements. Estimates of manpower requirements based on this framework will represent a valid evaluation of the total impact of the space program on military and civilian manpower. 9 pp. Illus.

- P-2052. Atmospheric entry.** Carl Gazley, Jr. 7-15-60. Unclassified.

A description of several types of atmospheric entry that may occur in the course of various space missions. The phenomena accompanying entry are also considered. In particular, the paper discusses (1) the dynamics of various types of entry, (2) the results of analytic and numerical solutions for the entry of both lifting and nonlifting vehicles into planetary atmospheres, (3) the effects of initial entry conditions and of the vehicle's gasdynamic characteristics on its motion and heating, and (4) the characteristics of several types of surface-protection and cooling systems and their application to various types of atmospheric entry. 106 pp. Illus. Incorporated in *Handbook of Astronautical Engineering*, ed. by H. H. Koelle, published by McGraw-Hill Book Company, Inc., New York, 1961. \$27.50.

- P-2053. The effect of maintenance and reliability on the operational effectiveness of an interceptor squadron.** R. S. LaVallee and D. S. Stoller. 8-2-60. Unclassified.

Data collected during a squadron operational test designed to measure the interceptor team effectiveness in accomplishing the air defense mission. This paper attempts to determine the impact of

maintenance or reliability on operational capabilities. The results are primarily useful in indicating order-of-magnitude effects and the importance of certain parameters on maintenance and reliability. The test environment, the data-collection procedures, and the accuracy obtained are also discussed. 52 pp. Illus. Presented before the Operations Research Society of America at Detroit, Michigan, October 10-12, 1960.

- **P-2054. A first estimate of initial surface motions produced by an underground explosion.** H. A. Lang. 8-2-60. Unclassified.

Motions determined by convolution using the known response of the surface to both a unit shear and a unit normal loading. Results are expressed by dimensionless displacement-time curves. The problem is intended to illustrate the construction of a primary seismogram. The method used is capable, in principle, of extension to more complex distributions of sources modeling explosions, faulting, and earthquakes. 84 pp. Illus. See also P-1498, P-1650, P-1755, and P-2215.

- **P-2055. A series expansion for $\log I_0(z)$.** Ivan Selin. 8-3-60. Unclassified.

An approximate expression for the general term in the power series expansion for the $\log I_0(z)$, the modified zero-order Bessel function of the first kind. 3 pp.

- **P-2056. Solving the chemical equilibrium problem using the decomposition principle.** G. B. Dantzig and M. B. Shapiro. 8-10-60. Unclassified.

A study concerned with obtaining the equilibrium composition of a gaseous mixture that is equivalent to determining the number of moles of each molecular species present that minimize the total free energy of the mixture. The convex function for free energy, as given by Gibbs, is minimized subject to the constraints of the mass-balance equations for the mixture. A solution of the problem is presented, using a version of the decomposition procedure for linear programming. The paper describes mathematically the method of solution, the computational algorithm as programmed for the IBM 704, and the results. 23 pp.

- **P-2057-RC. Water supply for southern California: rationalization or expansion?** Jack Hirshleifer. 8-12-60. Unclassified.

An attempt to determine whether the benefits from the Feather River Project justify the incremental cost of extending the aqueduct system to the Southern California Coastal Plain and Coastal San Diego County Service Area. The main alternative to the construction of the project is the rationalization of existing uses within the area by reallocating water so as to eliminate low-valued uses. The water will thus be limited to those uses in which its productivity is sufficiently great in comparison to the marginal cost of water supplies. 24 pp. Tables. Incorporated in *Water Supply: Economics, Technology and Policy*, The University of Chicago Press, Chicago, 1960. \$7.50. Presented before the Western Economic Association Conference at Stanford, California, August 26, 1960, and published in the proceedings of the Conference.

- **P-2058. A contribution to the dynamic elastic-plastic analysis of structures.** M. L. Baron, H. H. Bleich, and P. Weidlinger. 8-1-60. Unclassified.

A presentation of the finite difference method for elastic-plastic analysis of structures subjected to transient loads. This method is applied to a simply supported beam loaded by an exponentially decaying pressure. The results obtained (from the finite difference analysis) are compared with those given by simplified single mode elastic-plastic and rigid-plastic analyses to examine the appropriateness and range of validity of these simpler theories. 28 pp. Illus.

- **P-2059. The Korean War: political limitations.** H. A. DeWeerd. 8-5-60. Unclassified.

A discussion of the political factors that limited military action in the Korean War. The paper examines (1) the political-military thinking in the United States and Western Europe from 1945 to 1950 about the nature of a future war, (2) the influence of domestic American politics on the course of the Korean War, and (3) some effects of collective security considerations, especially those related to Western Europe. 14 pp. Presented before the American Historical Association Meeting at Seattle, Washington, September 8, 1960.

- **P-2062-RC. The future of data processing in state government.** E. F. R. Hearle and R. J. Mason. 8-8-60. Unclassified.

Forecasts on data-processing-equipment capabilities in the 1970's and suggestions as to how state governments should prepare themselves to use these capabilities most effectively. Data processing in

both manual and automatic systems is described in terms of (1) input, to acquire data and enter them into the system; (2) storage, to file data either temporarily or on a permanent basis; (3) processing, to manipulate data according to specified rules; (4) output, to present the results of the processing or the status of any data stored in the system; and (5) communication, to move the data from one point in the system to another. Better-designed information systems will lead to better decisions and ultimately to significant operating economies and improved state operations. 9 pp. Published in *State Government*, Winter 1961.

- P-2063. Recent developments in nonlinear programming—part I. P. S. Wolfe. 4-17-61. Unclassified.

The first of two studies surveying the basic features of the principal current proposals for the computational solution of nonlinear programming problems. These procedures are classified according to the techniques used and the type of problem to which they can be applied. This paper describes the kind of problem that will be studied and presents the gradient methods, one of the two classes of procedures used in nonlinear programming. 35 pp. Illus. For part II, see P-2333-1. Presented before the Fifteenth National Conference of the Association for Computing Machinery at Milwaukee, Wisconsin, August 24, 1960.

- P-2065. A model punched card system for production control. L. S. Hill. 1-6-61. Unclassified.

An integrated procedure for control of production using electric accounting machines. Such machines are used in the procedure to record, coordinate, and analyze all procurement, material control, cost control, and tool control data. Much of the effort in industry to date has been oriented toward the mechanization of clerical processes with relatively little effort on the total control system. This paper, then, is concerned with the development of a system for control of manufacturing from the time of raw material receipt through the transformation into finished product. An effective production control system can prove extremely useful in increasing production with decreased costs. 120 pp. Illus.

- P-2066. Surface waves in an elastic half-space. C. C. Chao, H. H. Bleich, and J. Sackman. 8-8-60. Unclassified.

A formulation of expressions to determine the effects of Rayleigh waves due to transient normal pressures on the earth's surface. Closed-form solutions are presented for the effect of a concentrated load, suddenly applied and maintained thereafter. Any general pressure distribution may then be treated by integration in space and time. 8 pp. Illus.

- P-2067. Synchronization of coherent detectors. I. Selin and F. Tuteur. 8-5-60. Unclassified.

The estimation of carrier frequency and subcarrier epoch in a "coded-noise" communication system. These are the parameters that constitute synchronization of the system. The estimation process is resolved into a sequence of detections, and the distribution of the time needed for an estimation to within a preset accuracy is given. 68 pp. Illus.

- P-2068. Observations of the blue haze in the atmosphere of Mars. A. G. Wilson. 8-9-61. Unclassified.

Some inferences about the Martian blue haze. From observed rates of formation and dissipation of the blue haze in the Martian atmosphere, the author infers that precipitation of carbon particles cannot explain the clearings, but that carbon can provide nuclei on which planetary or interplanetary matter may condense. 8 pp. Illus. Presented before the Symposium on the Planet Mars at Pasadena, California, August 29, 1961.

- P-2069. Hamiltonian paths on convex polyhedra. T. A. Brown. 8-16-60. Unclassified.

A discussion of those problems of linear programming in which an attempt is made to find all vertices of a given convex polyhedron. An algorithm for finding such vertices will often define a path that passes from vertex to vertex along the edges of the polyhedron in question. The problem considered is, Can a path always be found along the edges of a convex polyhedron that visits each vertex once and only once? The question is answered negatively, and a similar problem is solved that is a generalization of a famous old conjecture of P. G. Tait. 6 pp. Illus.

P-2070. The effect of interactions on determination of Fermi surfaces. E. A. Stern.
8-11-60. Unclassified.

A study of the effect of both electron-electron and electron-phonon interactions on a degenerate electron gas in a uniform positive background. It is shown that when electron-electron interactions alone are considered, the free electron mass is still measured by cyclotron resonance, the Faraday effect, and optical constants. However, the period of the de Haas-van Alphen oscillations is changed from the calculations made with interactions neglected and is changed in the same way as is the specific heat. When electron-phonon interactions are added, everything changes. In particular, it is shown that the cyclotron mass is no longer the free value, and that the de Haas-van Alphen period and the specific heat are changed in different ways. Comparison with measurements on aluminum that approximates the model used shows that both electron-phonon and electron-electron effects are important and of the same magnitude. 30 pp. Published in *The Physical Review*, June 15, 1961.

P-2071. Invariant imbedding and the reduction of two-point boundary value problems to initial value problems. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 10-4-60. Unclassified.

An application of the method of invariant imbedding to the reduction of quite general nonlinear systems of differential equations. A heuristic derivation of the results is presented, showing how such a system may be considered as representing mathematically a classical transport problem and then proceeding formally to the invariant imbedding analysis of the physical problem. A partial connection with classical characteristic theory is indicated, and a few examples are given. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, December 1960.

P-2072. The implications of some game-theoretic analyses for war gaming. L. D. Berkovitz. 8-25-60. Unclassified.

An examination of the appropriateness of war gaming as a device for determining the major features and significant details of optimal strategies. Several fairly realistic game models of tactical air warfare, which have been solved analytically, are presented. These games involve sequences of simultaneous moves, with a continuum of choices available to each side at each move. The question is then raised whether playing the game—which is essentially the testing of a finite number of alternatives at each move—will be a helpful device for learning about the solutions of the particular games presented. It is shown, in terms of these games, that war gaming, despite its usefulness for other purposes, is not a helpful device in determining optimal strategies. 17 pp. Illus. Presented before the Third War Games Symposium at Ann Arbor, Michigan, October 7, 1960, and published in the proceedings of the Symposium.

P-2073-RC. Introduction to the UNBER-SSRC conference volume on inventive activity. R. R. Nelson. 8-15-60. Unclassified.

An introduction to a volume of papers presented at a conference on inventive activity, held at the University of Minnesota, Minneapolis, May 12-14, 1960. The reasons for the developing interest in inventive activity are discussed, and the principal topics considered in the papers are outlined. Some of the problems treated are (1) the classical economics approach and the black box, (2) the concept of parallel inventive efforts, (3) the profits from inventions, (4) nonmarket factors, and (5) invention and policy. 20 pp. Presented before the Conference on Economic and Social Factors Determining the Rate and Direction of Inventive Activity at Minneapolis, Minnesota, May 12-14, 1960, and published in the proceedings of the Conference.

• **P-2074. Optimal replacement and inspection of stochastically failing equipment.**
D. W. Jorgenson and R. Radner. 8-16-60. Unclassified.

An investigation of the structure of optimal policies for replacement and inspection of stochastically failing equipment. Preparedness-type models of single-part equipment are used in an attempt to maximize the proportion of the time that the system is in a good, ready state. It is found that optimal replacement policies call for periodic replacement and that the optimal period is easily computed. In the case of equipment with several parts, there arises the possibility of opportunistic maintenance in order to take advantage of "economies of scale" in maintenance actions. In such cases, serious analytical difficulties are encountered, and optimal policies are shown to be too complicated for practical use. 39 pp.

- P-2075. Charge density in the wake of a point charge traveling in a plasma. P. H. Greifinger. 8-1-60. Unclassified.

An estimation of the integrals yielding the electron density in the wake far away from the traveling object for the case of no external magnetic field. 7 pp. Illus.

- P-2076. Compatibility of military and commercial airlift requirements. J. R. Summerfield. 9-21-60. Unclassified.

A restatement of the airlift requirements in terms of the characteristics of the demands for airlift on the part of military and commercial users. Those parts of the demands that are similar are indicated, as well as those parts in which the military and commercial requirements are in apparent conflict with each other. Where conflict appears in the requirements, the elements of conflict are translated into the characteristics of logistics systems to ascertain if, through compromise, military and commercial airlift systems can be derived that are reasonably compatible with each other. 18 pp. Presented before the Institute of Aeronautical Sciences National Midwestern Meeting on Air Logistics at Tulsa, Oklahoma, October 3, 1960, and published in the proceedings of the Meeting.

- P-2077. Southern California's economy in the sixties. D. M. Iklé. 8-17-60. Unclassified.

An attempt to determine whether California's steady rapid growth will continue in the sixties, especially if there should be a reduction in defense. The paper discusses the importance of the defense industry in Southern California, the outlook for defense expenditures in view of a possible disarmament agreement, the impact of disarmament on Southern California's economy, and the effect of the prosperity and expansion in the defense industry on supporting industries. 8 pp. Published in the *Southern California Prompter*, September 1960.

- P-2078. Measurements of effective radiated power. M. N. Lustgarten. 8-17-60. Unclassified.

A discussion of the requirements for data on effective radiated power (ERP), which will be needed in a suggested broad Air Force program in the field of electronic-system compatibility. ERP is defined as the power output of an emitter (at every frequency) that will be detected at any point in space by an ideal measuring device. The statistical model described (1) provides the system planner with a definite quantitative estimate of the confidence that can be placed on the measured data and (2) indicates those areas in which improved measurement techniques and measurement equipment are required. 19 pp. Illus. Presented before the Sixth Conference on Radio Interference Reduction, Armour Research Foundation, at Chicago, Illinois, October 4-6, 1960, and published in the proceedings of the Conference.

- P-2079. Mie scattering with complex index of refraction. D. Deirmendjian, R. J. Clasen, and W. Viezee. 8-19-60. Unclassified.

New machine computations and the resulting values of the exact Mie functions, related to the scattering of electromagnetic waves on partially absorbing spheres. Results are presented for various indices of refraction, chiefly those corresponding to atmospheric water particles illuminated by visible and infrared light, as well as those corresponding to solid particles in interplanetary space. 45 pp. Illus. Published in the *Journal of the Optical Society of America*, June 1961.

- P-2080. Paradoxes related to the rate of transmission of information. Peter Swerling. 8-17-60. Unclassified.

A discussion of paradoxes related to the possibility of infinite information capacity of certain types of channels. First, a paradox of this type is obtained that shows that such paradoxes are not necessarily dependent on the assumption of Gaussian statistics. Next, in the case in which signal and noise are assumed to be Gaussian, a different example of this type of paradox is determined. In addition, a necessary and sufficient condition for the avoidance of this form of the paradox is derived. The condition is shown to be satisfied in a class of plausible physical situations. 13 pp. Published in *Information and Control*, December 1960.

- P-2081-2. The imbedding of graphs in manifolds. J. W. T. Youngs, L. Auslander, and T. A. Brown. March 1962. Unclassified.

Consideration of the properties of graphs G_n ($n \geq 2$) and G_n^* ($n \geq 1$): (1) G_n and G_n^* can be imbedded in the simplest nonorientable 2-manifold, the projective plane; and (2) G_n and G_n^* can

be imbedded in an orientable manifold of genus n , but cannot be imbedded in an orientable manifold of genus less than n . It is shown in P-1785, *Printed Circuits, Graphs, Manifolds*, that the one-dimensional skeleton of any triangulation of a manifold of genus n has the second property. However, such graphs become very complicated as n increases. An attractive feature of the graphs G_n and G_n^* is their simplicity. 14 pp. Illus.

- P-2082. Aircraft compartment design criteria for the army deployment mission. W. F. Sharpe. 8-23-60. Unclassified.

An abridged version of RM-2566 of the same title. Cargo airlift capability is examined in connection with the army deployment mission. The bulk of army deployment cargo is vehicular, unlike the small units typical of peacetime cargo. Cargo floor area (square footage), not payload capacity (weight), is the major limiting factor on many present and future air carriers of army vehicles and other equipment. The analysis shows that because of the space limitation, an average of 51 lb of deployment cargo can be loaded per square foot of aircraft floor area. 25 pp. Illus. Presented before the Operations Research Society of America at Detroit, Michigan, October 11, 1960.

- P-2083. Functional equations in the theory of dynamic programming—XII: complex operators and min-max variation. R. E. Bellman and R. S. Lehman. 9-1-60. Unclassified.

An application of the functional-equation approach of dynamic programming to the study of variational problems associated with the Sturm-Liouville equation of second order with real coefficients. By obtaining the dependence of the Green's function on the interval length, the authors determine the corresponding dependence of the characteristic values and the characteristic functions, and similar results for vector-matrix systems. Min-max variation is used to apply the same general techniques to the study of equations with complex coefficients. It is shown that this method can be applied rigorously. 18 pp. Published in the *Duke Mathematical Journal*, September 1961.

- P-2084-RC. No highway to high purpose. A. J. Wohlstetter. June 1960. Unclassified.
- An article published in *Life* magazine, June 20, 1960, which discusses (1) the complex and partially conflicting national purposes of the United States, (2) ways to attain these aims, and (3) the effort needed. Part of the American dream is described as the desire to increase economic development, to reduce the risks of thermonuclear war, and to protect the political independence and self-development of the non-Communist world. Disarmament with the proper inspection controls is seen as a means to achieve these ends. It is emphasized that the American public must be willing to reduce its consumer spending and to be governed by reflection and choice to fulfill our national purposes. 16 pp.

- P-2085. The representation of planar graphs by convex polyhedra. T. A. Brown. 8-24-60. Unclassified.

A proof that any graph that can be represented as a triangulation of the sphere can be represented as the vertices and edges of a convex polyhedron. Three corollaries to this result (including Fary's theorem) are given. 15 pp.

- P-2086. Man-machine simulation progress. M. A. Geisler. 8-23-60. Unclassified.

A discussion of a technique that has been applied to studies of large logistics management systems in which decisionmaking under uncertainty is required. The procedure is to build man-machine simulations and to use them in experimental situations. The output is a description of decision rules, information flows, and an organizational structure that improve the cost and effectiveness of the logistics system. Man is used in these simulations for his learning, adaptiveness, and flexibility. Three such large-scale experiments have been conducted in the past 3 years. The technique is being further developed to be practicable with a wider range of problems by providing more aggregative and less costly simulations. 12 pp. Presented before the 1960 International Congress for Logic, Methodology, and Philosophy of Science at Stanford University, Stanford, California, August 24-September 2, 1960.

- P-2087. Sino-Soviet economic relations in recent years. Oleg Hoeffding. 12-15-60. Unclassified.

A discussion of the Soviet contribution to China's economic development. Such aspects are examined as (1) the history of China's association, or lack of association, with the Soviet-led effort to promote economic integration in the bloc; (2) the history of the Soviet effort to draw China into more

orderly bilateral trade relations governed by a long-term agreement; (3) China's debtor status vis-à-vis the USSR, and her resulting balance-of-payments problem; and (4) the highly fluctuating, and rather disorderly, course of Sino-Soviet trade from 1957 to 1959, reflecting a drastic Chinese adjustment to her balance-of-payments problem and the impact of the "big leap forward" on China's demand for imports. 27 pp. Tables. Published in *Ost Europa Wirtschaft*, May 1961. Presented before the Third International Sovietological Conference at Tokyo, Japan, September 19-24, 1960.

- **P-2088-2. Is investment really unimportant?** B. F. Massell. 6-1-61. Unclassified.

Evidence, on the basis of an interindustry comparison, that advances in technology are partially a result of investment activity although earlier results show investment to be relatively insignificant as a contributory factor in the growth process. This paper indicates that large changes in technology are accompanied by expenditure on structures, that technology seems to be inversely related to the ratio of fixed capital to inventory, and that a positive relationship is noted between the technology level and the wage rate. 37 pp. See also P-2090-2 and P-2510.

- P-2089-3. Research and economic growth: the role of public policy.** B. F. Massell and R. R. Nelson. 8-10-61. Unclassified.

An attempt to determine (1) whether the government should consciously pursue a set of policies toward scientific research expressly designed to accelerate the economic growth rate, and (2) what kind of measures are needed. To show how research contributes to economic progress, such problems are analyzed as the process by which research activity is translated into economic progress and the factors which determine the magnitude and structure of our research effort. The authors feel that government policy toward science should recognize the division of labor between governmental and private units and should focus on those areas of science where private incentives do not adequately reflect the public interest. The challenge posed by the Soviet Union is but one of several reasons for the increased interest in economic growth. 17 pp. Published in the *California Management Review*, Winter 1962.

- P-2090-2. A disaggregated view of technical change.** B. F. Massell. 6-9-61. Unclassified.

An attempt to measure the relative importance of "intraindustry" and "interindustry" technical change. The latter, which results from factors of production shifting among industries, leads to a discrepancy between the aggregate rate of technical change and a weighted sum of industrial rates. Nearly one-third of aggregate technical change is accounted for by interindustry change, mostly a result of capital mobility. 24 pp. Tables. See also P-2088-2 and P-2510. Published in *The Journal of Political Economy*, December 1961.

- **P-2091. An empirical description of the prisoner's dilemma game.** L. B. Lave. 9-14-60. Unclassified.

A discussion of recent experimental work with the prisoner's dilemma game, indicating low levels of cooperation and concluding that the Luce and Raiffa conjecture—that reasonable men will cooperate if the game is iterated—is unsubstantiated. This paper (1) presents the results and techniques used to obtain the higher levels of cooperation that will enable a case to be made for the Luce and Raiffa conjecture and (2) attempts to compare the results and to explain discrepancies. Differences in experimental technique appear to account for the contradictory results. The principal differences in technique are shown to be methodological, stemming from the dichotomous areas of interest between economics and psychology. 21 pp. Illus. Presented before the Research Fellows of the Center of International Affairs at Cambridge, Massachusetts, August 11, 1961.

- P-2092. Statistical methods in Markov chains.** P. P. Billingsley. 9-6-60. Unclassified.

A survey of the mathematical aspects of statistical inference as it applies to finite Markov chains, the problem being to draw inferences about the transition probabilities from one long, unbroken observation of the chain. The topics covered include Whittle's formula, chi-square and maximum-likelihood methods, estimation of parameters, and multiple Markov chains. It is indicated how these methods can be applied to a process with an arbitrary state space or a continuous time parameter. 57 pp. Published in *The Annals of Mathematical Statistics*, January 1961. Presented before the Institute of Mathematical Statistics Conference at Stanford, California, August 23, 1960.

P-2093. The importance of individual industries for defense planning. D. V. T. Bear and P. G. Clark. 9-15-60. Unclassified.

An examination of plausible supplies and demands in the U.S. economy after a nuclear war from the standpoint of peacetime defense preparations. The paper (1) defines a list of potential economic targets and studies aggregatively the distribution of economic resources among them, (2) discusses two general premises underlying the analysis of prospective demands after a war of the severity of a standard 80-city attack, and (3) speculates on postwar relative values to guide peacetime actions designed to narrow prospective supply-demand imbalances. It is concluded that the metal-working durable-goods industries deserve particular attention in devising civil-defense policies to accelerate postwar economic recuperation. 22 pp. Illus. Presented before the American Economic Association at St. Louis, Missouri, December 28-30, 1960, and published in the proceedings of the meeting.

P-2094. Successive approximations and computer storage problems. R. E. Bellman. 9-19-60. Unclassified.

An attempt to show how the method of successive approximations can be used to obtain the solution of nonlinear differential equations with two-point boundary conditions without storing the values of the previous approximation. 8 pp. Published in the *Communications of the Association for Computing Machinery*, May 1961.

P-2095. Liquid propellant rockets—1960. Martin Goldsmith. 9-8-60. Unclassified.

A review of developments in liquid-rocket-engine technology from September 1, 1959, to August 31, 1960. 9 pp. Published in *Astronautics*, November 1960.

P-2097. The use of protocols in programming research. D. L. Reich. 9-12-60. Unclassified.

A discussion of the use of protocol as a tool in programming research. Eight protocols are presented with brief analyses. 118 pp.

P-2098. Moscow, Peking, and Japan: views and approaches. P. F. Langer. 9-12-60. Unclassified.

An examination (1) of the views of the Soviet Union and Communist China toward Japan and (2) of some aspects of their strategy toward that country. Divergency in the approaches of Moscow and Peking toward Japan is indicated, both for what these approaches suggest about current trends within the Sino-Soviet alliance and for what they reveal about the two communist powers' short-range objectives. 30 pp. Incorporated in *Unity and Contradiction: Major Aspects of Sino-Soviet Relations*, ed. by K. L. London, published by Frederick A. Praeger Inc., New York, 1962. \$7.50. Presented before the Third International Sovietological Conference at Tokyo, Japan, September 19-24, 1960.

● **P-2099. Utilization of space from a national standpoint.** R. W. Buchheim. 9-13-60. Unclassified.

A talk presented before a meeting—sponsored jointly by the Society of Automotive Engineers, Inc., and the Air Force Office of Scientific Research—at Los Angeles, California, October 10-14, 1960. The paper discusses the conduct of scientific research in space, large-scale exploration, astronautical competition with Russia, and the use of U.S. industrial capacity. 8 pp.

● **P-2100. An affine field description of gravitation electromagnetism and matter.** D. G. B. Edelen. 9-14-60. Unclassified.

An examination of the adequacy of the Affine Field Theory as a descriptive geometric structure for the representation of physical events. It is shown that the theory leads to a derivation of elemental matter from purely geometric considerations in an abstract affinely connected space and that it yields equations that describe mesonic phenomena in a "physical" space of four dimensions of the Riemann variety. The meson character arises solely from the interactions of gravitational and electromagnetic fields, where only geometric arguments enter into the Lagrangean function and where the field mass is an integration constant. In addition, it is shown that the theory also describes macroscopic matter, Maxwell-Lorentz electrodynamics, and gravitational fields interacting with uncharged matter in the absence of electromagnetic fields. 46 pp.

P-2101. Theory of auroral morphology. J. W. Kern and E. H. Vestine. 9-15-60. Unclassified.

A new theory of auroral morphology based on the production of instabilities in electron sheets. The theory predicts the relative duration of homogeneous auroral arcs and the morphological sequence for these displays from general glow, through arcs, to rays and draperies. In addition, the theory explains the development of brighter features in such displays and the horizontal and vertical wave progressions observed in flaming aurora. 32 pp. Illus. Published in the *Journal of Geophysical Research*, March 1961.

P-2102-RC. Mathematical models of chemotherapy. R. E. Bellman, J. A. Jacquez, and R. E. Kalaba. 9-12-60. Unclassified.

A paper on the kinetics of distribution of an injected compound. This study, motivated by the desire for a theoretical framework for analysis of results with various agents used in cancer chemotherapy, is also of general importance to physiology and pharmacology. The advantages of high-speed computers are mentioned in circumventing many of the analytical difficulties and in experimentation. 17 pp. Illus. Presented before the Fourth Berkeley Symposium on Mathematical Statistics and Probability at Berkeley, California, June 20-24, 1960, and published in the proceedings of the Symposium.

● **P-2103. Some observations on capital longevity.** B. F. Massell. 9-19-60. Unclassified.

A paper containing (1) some remarks on the relationship between the longevity of a capital asset and the annual services provided by the asset, and (2) an empirical observation concerning the nature of the change in capital longevity in the U.S. economy. 10 pp. Tables.

P-2104. The reciprocity formula for multidimensional theta functions. R. E. Bellman and R. S. Lehman. 11-8-60. Unclassified.

Proof of the reciprocity formula for multidimensional theta functions. The proof is based on the idea that an identity can be proved (1) by first finding a set of conditions that uniquely determines the function represented by the expression on one side of the identity and (2) by then verifying that these conditions are satisfied by the function represented by the expression on the other side. 14 pp. Published in the *Proceedings of the American Mathematical Society*, December 1961.

● **P-2105. Statistics of hyperbolic error distributions in data transmission.** Pierre Mertz. 9-23-60. Unclassified.

A presentation of several statistical quantities consistent with hyperbolic error distribution. These quantities are compared with the corresponding quantities for a Poisson distribution. It is tentatively concluded that the agreement with the hyperbolic formulas is significantly better and more useful than with Poisson formulas. 27 pp. Illus. Presented before the Institute of Radio Engineers National Convention at New York, New York, March 20-23, 1960.

● **P-2106. Semi-coherent detection.** I. S. Reed. 9-19-60. Unclassified.

A method for encoding and transmitting messages over a radio frequency channel which could be shifted in frequency by a Doppler frequency. The receiver-detection process described avoids the necessity of a precise knowledge of the Doppler shift. It is only necessary to know the frequency band in which the shift lies. With this semi-coherent detection process, the need for either a filter bank of matched filters or a Doppler tracking filter is avoided. In view of the receiver simplicity, this communications technique could well have application in communicating to satellites and space probes. Its detection sensitivity is comparable to square-law detection over the same time-bandwidth product. 16 pp. Illus. Presented before the International Scientific Radio Union Meeting at the University of Colorado, Boulder, Colorado, December 12, 1960.

P-2107. Appraising Soviet astronautics. F. J. Krieger. 1-17-61. Unclassified.

A paper presented before the American Management Association, Inc., in New York City, October 5, 1960, as part of a research and development briefing session on "Finding a Place for Your Company in Space-age Technology." Soviet astronautics are discussed from the standpoint of their scientific, technical, military, and political aspects. In particular, the study examines (1) the emphasis on science and technology in the Soviet five-year plans, (2) the factors contributing to the rise of

the USSR from a backward nation to a dominant world power, (3) the history of the Soviet space-technology program, and (4) Soviet success in areas of propulsion, guidance, and complex automatic control systems. 30 pp. Illus. Published in *Bulletin No. 7 of the American Management Association*, October 1960.

- **P-2108. Space exploration: a national challenge.** R. W. Buchheim. 9-16-60. Unclassified.

Comments on a variety of topics concerning space exploration and having significance for administration of research. 13 pp. Presented before the 14th National Conference on the Administration of Research at Ann Arbor, Michigan, September 20, 1960.

- **P-2109. Diffraction of a pressure wave by a cylindrical cavity in an elastic medium.** M. L. Baron and A. T. Matthews. October 1960. Unclassified.

A description of the interaction of an infinitely long cylindrical cavity with a plane shock wave, the front of which is parallel to the axis of the cavity. The analysis considers an infinite elastic homogeneous and isotropic medium. The total stress field produced by the incoming pressure wave is obtained by superimposing the free field stresses and appropriate surface tractions to make the boundary of the cavity a traction-free surface. Numerical results are presented for the hoop stresses at the boundary of the cylindrical cavity. 25 pp. Illus.

- **P-2110. Measurements of sphere drag from hypersonic continuum to free-molecule flow.** D. J. Masson, D. N. Morris, and D. E. Bloxson. 9-27-60. Unclassified.

A study designed to measure the drag of spheres from the continuum through the transitional region and well into free-molecule flow. The tests were conducted in a Hotshot-type wind tunnel with air at stagnation temperatures of approximately 2500°K and 9000°K and with helium at stagnation temperatures varying from 1600°K to 4000°K. Mach numbers in the test section varied from 11 to about 60, with free-stream Reynolds numbers ranging from 15,000 down to about 30. All the test results can be correlated by a parameter that is proportional to the ratio of the mean free path behind the shock wave to the shock-detachment distance. The measured drag coefficient increases from the continuum value (0.92) to a level in the free-molecule flow regime of approximately 2.0. 39 pp. Illus. Also published as RM-2678. Presented before the Second International Symposium on Rarefied Gas Dynamics at Berkeley, California, August 5, 1960, and published in the proceedings of the Symposium.

- **P-2111-AEC. Probing the earth with nuclear explosions.** D. T. Griggs and F. Press. 11-14-60. Unclassified.

A review of the progress in seismology, with emphasis on the usefulness of past nuclear-weapon tests in determining the internal structure of the earth. Shot times and locations are tabulated for 169 U.S. atomic explosions, with seismic data from Pasadena. The paper discusses the advantages of using large chemical explosions and future nuclear explosions detonated under the *PLOWSHARE* program as controlled energy sources for carefully instrumented seismological experiments. Finally, an international program of explosions for seismological research is proposed, and specific suggestions are made for attacking several outstanding problems in seismology by means of chemical and clean nuclear explosions and the instrumentation network proposed at Geneva for nuclear-test detection. Deep oceanic seismometer lines are proposed as a means for making important improvements in seismic knowledge of the world and possible improvements in the detection of atomic explosions. 44 pp. Illus. Published in the *Journal of Geophysical Research*, January 1961.

- **P-2112. Operational design criteria for missile ground systems: readiness testing.** S. I. Firstman. 9-15-60. Unclassified.

An example of the application of operations research to missile ground system design. The paper discusses the roles of operations research in equipment design and the general readiness-testing design problem. For this problem, analyses are needed to specify: what tests are best done by each test method, the best test frequencies, and preferred equipment locations for each test. The essence of an analysis is provided, using Markov processes to describe the system operation, and a discrete programming formulation for the decision process. 29 pp. Illus. Presented before the Operations Research Society of America at Detroit, Michigan, October 10-12, 1960.

P-2113. Molecular flow study of the hypersonic sharp leading edge interactions.
A. F. Charwat. 8-5-60. Unclassified.

An analysis (by kinetic near-free-molecule techniques) of the initial disturbance to the free stream over a sharp edge flat plate in hypersonic rarefied flow. It is shown that the collisions between the molecules emitted by the surface and the incident ones cause a violent transformation of streamwise into cross-stream momentum that results in a rise of the pressure on the plate. The slope of the initial pressure rise is calculated. A maximum pressure and its location downstream of the leading edge are implied and predicted as a function of the density, the flight Mach number, and the wall temperature. 45 pp. Illus. Presented before the Second International Symposium on Rarefied Gas Dynamics at Berkeley, California, August 3-5, 1960, and published in the proceedings of the Symposium.

P-2114-1. Attitudes toward intelligent machines. Paul Armer. 5-1-62. Unclassified.

An examination of comments and attitudes on intelligent machines taken from literature of the United States and the Soviet Union. To help reduce some of the semantic difficulties frequently associated with discussions of artificial intelligence, the proposition is advanced that research on intelligent machines should be viewed merely as an attempt to push machine capabilities farther out in the continuum of intelligent behavior. 37 pp. Presented before the Bionics Symposium at Wright-Patterson Air Force Base, Ohio, September 13, 1960, and published in the proceedings of the Symposium.

● **P-2115. Experience in the use of a simulation laboratory in the design of a management information system.** K. H. Labiner and J. D. Tupac. 10-3-60. Unclassified.

A description of the information system used in Laboratory Problem II (LP-II), a manned-simulation experiment designed to evaluate alternative sets of proposed logistics policies for an ICBM force. The purpose of the management information system is to maximize missile-firing capability with the resources available. The experience gained from the experiment shows (1) that the manned-simulation technique used is free of many deficiencies in traditional methods of information-system design and offers peculiar advantages of its own, and (2) that the concepts and features of this management information system may be useful for an analogous Air Force organization. 7 pp. Illus. Presented before the Operations Research Society of America at Detroit, Michigan, October 10-12, 1960.

● **P-2116-1. Introduction to sequential circuits.** I. S. Reed. 3-17-61. Unclassified.

A description of the synchronous sequential circuit. A method for implementing a sequential circuit is described, and an outline of a proof of the merging process is presented in set-theoretic language. 28 pp. Illus. Presented before the American Institute of Electrical Engineers at Chicago, Illinois, October 10-12, 1960.

P-2117. The "contextual study" method as a device for studying limited-war strategies. T. E. Greene. 10-10-60. Unclassified.

A discussion of the "contextual study" method for studying limited-war strategies in conjunction with war gaming. The method is designed to provide a means of accounting for the dynamic interaction of political variables with physical variables. A seminar approach is used relying primarily on the criteria of relevancy and credibility (as defined by the author). 16 pp. Presented before the Third War Games Symposium at the Willow Run Laboratories, University of Michigan, Ann Arbor, Michigan, October 8, 1960, and published in the proceedings of the Symposium.

● **P-2118. Capital intensity as a mitigation of inferior labor: a general theorem.**
Stephen Enke. 10-10-60. Unclassified.

A discussion of Hirschman's thesis on the contrast between continuous-process activities with other productive activities in which work sequences are less rigidly determined. The author paraphrases Hirschman's argument, suggests modifications, and presents a more general theorem. It is indicated that only countries with inferior labor should adopt more capitalistic methods of production if relative factor prices are the same. However, backward countries will usually have higher interest rates relative to hourly wage rates. It therefore remains indeterminate which country should have higher capital-to-labor ratios, in producing some given good. 9 pp. Illus.

P-2119. On measuring productive potential and relative efficiency. R. H. Moorsteen. 10-15-60. Unclassified.

A study showing that for every comparison between two economies there are conceptually four indexes of relative efficiency, which will undoubtedly vary among themselves. With the use of actual price, input and output data, and the assumptions necessary to compute input or output indexes separately, two of the efficiency indexes can be computed. If it is assumed that substitutabilities among outputs do not vary with the input mix, the other two efficiency indexes can be computed as well. Each of the four efficiency indexes measures something different, and each fails to show the relative efficiency for the case in which each economy produces in its own proportions from inputs combined in its own proportions. 36 pp. Illus. Published in the *Quarterly Journal of Economics*, August 1961.

P-2120. The dynamics of the upper atmosphere and its energy unbalance. W. W. Kellogg. 10-1-60. Unclassified.

A review of observations and current theories on the dynamics of the upper atmosphere. Energy sources and energy sinks of the upper atmosphere are discussed and, where possible, are shown in their relationship to the motions of air above the tropopause. Evidences of upper air motion are outlined, as are modern conjectural explanations for such motion. 15 pp. Illus. Presented before the American Astronautical Society at Dallas, Texas, January 16, 1961.

P-2121. Calculations of cloud electrification based on a general charge separation mechanism. J. D. Sartor. 10-12-60. Unclassified.

A description of a mechanism for selectively transferring charge in clouds in a way that enhances the normal atmospheric electrostatic field. Calculations using observed cloud and rain-drop size distribution give electrostatic fields of the magnitude observed in thunderstorms within the observed time. 21 pp. Illus. See later version P-2345. Published in the *Journal of Geophysical Research*, March 1961.

P-2122. Invariant imbedding and variational principles in transport theory. R. E. Bellman, R. E. Kalaba, and G. M. Wing. 12-12-60. Unclassified.

A study showing the possibility of formulating a variational problem that when analyzed from the classical Euler equation viewpoint, yields the usual transport equations, and when analyzed from the functional equation viewpoint of dynamic programming, yields the Riccati-like equations for the reflected fluxes ordinarily obtained using invariance principles. This duality provides conceptual, analytic, and computational advantages for the mathematical treatment of transport processes. 6 pp. Published in the *Bulletin of the American Mathematical Society*, July 1961.

● **P-2123. Gaming limited war.** M. G. Weiner. 10-27-60. Unclassified.

A discourse on limited war and on its many related areas of interest (e.g., the causes of limited war, ways to keep it limited, the weapons necessary to fight such wars, and the role of international commitments, support agreements, and assistance pacts). Limited war gaming at RAND is described as a technique developed to answer these questions, and some of the ways in which the analysis of these hypothetical wars may be used are examined. 12 pp. Presented before the Sixth West Coast Classified Military Operations Research Symposium at San Francisco, California, October 20, 1960.

● **P-2124. The importance of individual industries for defense planning: supplemental data.** D. V. T. Bear and P. G. Clark. 10-18-60. Unclassified.

A supplement to P-2093, *The Importance of Individual Industries for Defense Planning*, which examines plausible supplies and demands in the U.S. economy after a nuclear war from the standpoint of peacetime defense preparations. This paper presents data on (1) manufacturing value-added and population of 313 U.S. cities, (2) postwar supplies of individual industries, (3) postwar demands on individual industries, and (4) postwar importance ratios for individual industries. 33 pp. Illus.

P-2125. On convexity, efficiency, and markets. F. M. Bator. 10-19-60. Unclassified.

A discussion of M. J. Farrell's article, "The Convexity Assumption in the Theory of Competitive Markets," in which claims are made to reduce the minimum assumptions necessary for the validity of the "received theory." Mr. Farrell charges the author and Mr. J. deV. Graaff for an error made in their analogy between competitive markets and one-man economies. This paper substantiates Mr.

Graaff and the author's position and examines Farrell's claim to have broadened the basis of the received theory. Only those parts of the Farrell paper are considered that deal with nonconvexity in production functions. 12 pp. Published in *The Journal of Political Economy*, October 1961.

- **P-2126. Variable atmospheric properties derived from rocket and satellite observations.** H. K. Kallmann-Bijl. 10-20-60. Unclassified.

A presentation of upper air densities obtained by means of rockets and satellites in the region from 100 km to about 800 km. Pressures and scale heights are derived from densities, and preliminary mean values and day and night values are obtained. From the variation of scale height with altitude, regions of constant temperature and of variable molecular weight are determined. 16 pp. Illus. Presented before the Symposium of the Advisory Group for Aeronautical Research and Development at Athens, Greece, June 20-24, 1960.

- **P-2127. The use of heuristic programming in management science.** F. M. Tonge. 12-12-60. Unclassified.

A survey of the present and potential use of heuristic programming in management science. Intelligent problem-solving, whether by man or by machine, implies selective rather than just rapid behavior. Humans achieve this selectivity through heuristics (i.e., principles that, on the average, contribute to reduction of search in problem solving). Heuristic programming is the construction of computer problem-solving programs whose behavior is similarly organized. 14 pp. Published in *Management Science*, April 1961. Presented before the Institute of Management Science at New York, New York, October 21, 1960.

- **P-2128. Perspectives of dynamic programming.** R. E. Bellman. 10-24-60. Unclassified.

A discussion of three principal areas for future research in the theory of dynamic programming. 6 pp.

- **P-2129. Infrared.** Sidney Passman. 10-25-60. Unclassified.

A discussion of the significant aspects of the generation, transmission, and detection of infrared radiation. Infrared utility includes information on identity, intensity, and spectral quality of a source, and employment in military problems of detection and tracking of an identifiable target. 14 pp. Illus.

- **P-2130. Dynamic programming, Fermat's principle, and the eikonal equation.** R. E. Kalaba. 10-17-60. Unclassified.

A demonstration of how the eikonal equation may be derived directly from Fermat's principle of least time using Bellman's principle of optimality. It is also suggested that Huygen's principle will play a significant role in automatic control theory. 6 pp. Illus. Published in the *Journal of the Optical Society of America*, October 1961.

- **P-2131. New directions in the application of game theory: an abstract.** L. S. Shapley. 10-28-60. Unclassified.

An outline of the game-theoretic approach to a number of different competitive situations in economics, including an auction, a duopolistic price war, several larger market models, and a stockholders' meeting. The discussion is intended to illustrate the scope of the n -person, nonconstant-sum theory, as opposed to the more familiar minimax theory of two-person, constant-sum games. 6 pp. Presented before the Institute of Management Sciences at New York, October 21, 1960.

- **P-2132. Methods of solution of linear programs under uncertainty.** Albert Madansky. 11-8-60. Unclassified.

A discussion of the uncertainty in most linear-programming problems, an uncertainty that is found in either the technology matrix, the right-hand side, or the cost. Some of the more usual methods of reducing the effects of uncertainty are those of (1) replacing the random elements by their expected values, (2) replacing the random elements by pessimistic estimates of their values, and (3) recasting the problem into a two-stage problem in which, in the second stage, the "inaccuracies" can be compensated for in the first-stage activities. These methods are called the expected-value solution, the "fat" solution, and the "slack" solution, respectively. This paper examines the one-stage linear program under uncertainty, indicating the relation between these various "solutions." 15 pp.

P-2133-1. Consumption levels in the Soviet Union and the United States. J. G. Chapman. September 1961. Unclassified.

A comparison of the level and pattern of consumption in the Soviet Union with present and past levels and patterns of consumption in the United States. The major similarities and differences are also analyzed. Considering Soviet development as a case of economic growth, an attempt is made to indicate those aspects of Soviet consumption which appear to be primarily related to the stage and level of economic growth. However, the explanation must often be found in the particular time and place of Soviet economic development and in the policies of the rulers of the Soviet planned economy. 78 pp. Tables. Presented before the Conference on Economics of Soviet Industrialization at Princeton, New Jersey, May 6-8, 1961, and published in the proceedings of the Conference.

P-2134. The role of the electrostatic field in the coagulation of fog and cloud droplets. J. D. Sartor. 1-25-60. Unclassified.

Findings on the degree to which electrostatic forces act to modify the motion of cloud droplets. The electrostatic field of the atmosphere is normally enhanced in fog and cloud. This field, even when quite small, can effect the combination of droplets that otherwise would collide but not coalesce. Stronger fields produce forces of mutual attraction among the droplets. Methods for the possible modification of the field are discussed. 14 pp. Illus. Presented before the First Fog Research and Modification Planning Session at Boston, Massachusetts, January 25 and 26, 1960, and published in the proceedings of the Session.

- **P-2135. Identifying R&D: a management problem.** David Novick. 12-1-60. Unclassified.

A talk presented before the SAC-Omaha Chapter of the Armed Forces Management Association, at Offutt Air Force Base, Nebraska, November 17, 1960. Research and development, and its relationship to SAC, are discussed. The author stresses that to win the technological race, ever-increasing amounts must be spent on R&D. An adequate classification system for R&D must also be created. Two dangers will thereby be avoided: that of trying to maintain an adequate deterrence with obsolete weapons and that of the inability to learn, without waste of resources and people, how best to use new and advanced weapons now under development. 21 pp. Illus.

P-2136-RC. The RAND study of water supply. J. C. DeHaven. 11-3-60. Unclassified.

A review of the RAND-sponsored study of water supply and a résumé of the design and conclusions of the study. The study attempts to show that the correct application of economic principles will produce the greatest efficiency in water-supply procurement and use in relation to, and in competition with, all the other desires of the community, and as based on the values established by the community. Many of the conclusions reached are at variance with present practice governing the use of existing water supplies and the development of new supplies. A major change, rather than merely a marginal modification, in the trend of current practice and thought on water-supply problems is in order. 21 pp. Incorporated in *Water Supply—Economics, Technology, and Policy*, published by The University of Chicago Press, Chicago, Illinois, 1960. \$7.50. Presented before The RAND Corporation Board of Trustees at Santa Monica, California, November 5, 1960.

- **P-2137. Minimum-weight proportions of pressure vessel heads.** G. A. Hoffman. 11-11-60. Unclassified.

A derivation of minimum-weight shapes of head closures for cylindrical pressure vessels. Head configurations, weights, and membrane stresses are obtained for thin-shell heads of isotropic materials with uniform internal pressure (1) by restricting the knuckle shear stresses to constant values where possible, and (2) by minimizing the weight of prescribed-shape heads. Certain highly efficient shapes are obtained that weigh up to 11 per cent less than the corresponding hemispherical capping closure. 31 pp. Illus. An abridgment of RM-2675.

- **P-2138. Problems of force posture evaluation.** D. C. McGarvey. 1-30-61. Unclassified.

A discussion of methods of computation and of the reporting of results that provide the decision-maker or evaluator with synthetic experience in central war. By emphasizing flexible methods for quick computation, the user can ask questions of the model, test particular hypotheses or doctrines, and examine the effects of unpredictables. The resultant model is useful in determining various

strategic doctrines and force-posture decisions. Methods of computing mortalities and casualties are presented in an appendix. 17 pp. Presented before the Operations Research Society of America at Detroit, Michigan, October 10, 1960.

P-2139. An application of mathematical programming to physiology: the human respiratory system. G. B. Dantzig and J. C. DeHaven. 11-10-60. Unclassified.

A résumé of research exploring the applicability of mathematical programming techniques of biological systems (discussed in RM-2519). A mathematical simulation of the external respiratory function is presented to illustrate the thesis that important subsystems of the human body can be studied by mathematical-programming techniques that have been used to program and control complex military and industrial systems. 35 pp. Illus. See also P-2048 and P-1811. Presented before the Air Pollution Medical Research Conference at San Francisco, California, December 7, 1960, and published in the proceedings of the Conference.

P-2140. Mechanics of some limited disarmament measures: a simple economic treatment. A. R. Ferguson. 1-23-61. Unclassified.

An attempt to determine how disarmament measures affect the economics of military power. The study suggests that although the broader the definition of weapon systems limited by an arms control measure, the greater is its effect, if successive expansion in scope is possible. If one agreement is expected to make successive ones easier, the expected arms control effect of a measure of narrow scope is greater than would otherwise be the case. "Narrow" arms control measures may, under the restricted conditions assumed, tend to be mutually reinforcing both in a simple sense and in that they may make secret, illicit capability disproportionately difficult. The fact that a weapon system is inefficient, and not used, does not necessarily mean that its proscription would have an expected arms control effect of zero. Some tentative implications for research are also suggested. 19 pp. Illus. Published in *The American Economic Review*, May 1961. Presented before the American Economic Association at St. Louis, Missouri, December 28-30, 1960.

P-2141. Similarity solution for cylindrical magnetohydrodynamic shock waves produced by a line current which increases linearly with time. C. Greifinger and J. D. Cole. 11-18-60. Unclassified.

Consideration of a case in which a uniform magnetic field parallel to the axis is initially present in the gas. In this case a transverse magnetohydrodynamic shock wave results from the current discharge. The flow is analyzed under the assumptions that the plasma is a nonviscous, nonheat-conducting, ideal gas of infinite electrical conductivity, and that the discharge current increases linearly with time. It is found that the speed predicted by the snowplow theory is in very good agreement with the speed of the contact front obtained from the solution of the full equations over the entire range of shock strength, but that the snowplow speed is a good approximation to the shock speed only in the limit of strong shocks. The effect on the flow of varying the axial field is discussed. 32 pp. Illus. Published in *The Physics of Fluids*, May 1961. Presented before the Symposium on Magnetohydrodynamics at the California Institute of Technology, Pasadena, California, December 9, 1960.

P-2142. New areas of application of computers. Allen Newell. 11-21-60. Unclassified.

A discussion of the evolution of computer applications. The current range of applications consists of engineering calculation, business-data processing, preparation of Bible concordances, prediction of election returns, discovery of new chemical names, composition of elementary music, solution of double-croscics, and a program that plays solitaire. Future applications suggested are the handling of large hydrodynamic problems and of raw language, and the development of elementary language-understanding programs. 4 pp. Published in *Datamation*, January 1961.

P-2143. Risk, the discount rate, and investment decisions. Jack Hirshleifer. 11-21-60. Unclassified.

A presentation of a simple market theory of risk, modelled on Fisher's treatment of time-preference and interest. An attempt is made to show how the criterion of maximizing present value as the guiding principle for evaluating riskless investment alternatives- must be modified or generalized when risky investments are considered. The appropriate rate of discount to use in the present-value

formula is indicated to allow for uncertainty of return as well as for futurity of return. 14 pp. Illus. Published in *The American Economic Review*, May 1961. Presented before the American Economic Association at St. Louis, Missouri, December 28-30, 1960.

P-2144. On the generation of normal random vectors. E. M. Scheuer and D. S. Stoller. 11-21-60. Unclassified.

A discussion of two methods for generating random vectors from a multivariate normal population with a specified variance-covariance matrix. The generation of normal random vectors with given covariance matrix Σ is best accomplished by the method based on matrix equations. The method based on conditional distributions may be economical in some special instances, but otherwise will usually be inferior to the matrix equation method. 7 pp.

P-2145. On various versions of the defective coin problem. R. E. Bellman and B. Gluss. 1-17-61. Unclassified.

An analysis of the problem of ascertaining the minimum number of weighings which suffice to determine the defective coin in a set of N coins of the same appearance, given an equal arm balance and the information that there are two or more defective coins present. An attempt is made to indicate a systematic way in which the theory of dynamic programming can be used to provide a computational solution to determine optimal and suboptimal testing policies. This is illustrated by means of some numerical results obtained using a digital computer. 22 pp. Tables. Published in *Information and Control*, September 1961.

P-2147. The nature and function of military R & D. B. H. Klein, W. H. Meckling, and E. G. Mesthene. 11-4-60. Unclassified.

A description of research and development for the military. Research and development is an uncertain and unpredictable business while at the same time it reduces uncertainty by buying knowledge. The need for many kinds of knowledge is indicated, along with the sequential character of research and development. Five rules of good development policy are also included. 6 pp. Incorporated in R-333. Also an introduction to *Research and Development Reliability*, published by the American Society for Quality Control, Milwaukee, Wisconsin, February 1961. \$4.00.

P-2148-1. Soviet national income. Abram Bergson. October 1961. Unclassified.

An attempt to determine Soviet national income from 1928 to 1958 by a comparative evaluation of the Soviet rate of growth of total output and the rate of growth of factor productivity. Trends in Soviet national income are also compared with those of the United States in both early and recent years to gain insight into the Soviet growth process and into the relative economic efficiency of competing social systems. 74 pp. Tables. Presented before the Conference on Economics of Soviet Industrialization at Princeton, New Jersey, May 6-8, 1961.

P-2149-1. Investment, innovation, and growth. B. F. Massell. November 1961. Unclassified.

An examination of the evidence that the major part of the increase in average labor productivity in the United States over the past 40 years has resulted from technical progress. While some technical change may be wholly "organizational," most improvements in technology are likely to be incorporated in new capital goods, so that technical progress requires a positive rate of gross investment. This relationship between investment and technical progress is considered in the context of a highly simplified model, and an attempt is made to reassess the contribution of investment to economic growth. 22 pp. Illus. Supersedes P-2017. Published in *Econometrica*, April 1962. Presented before the Econometric Society at St. Louis, Missouri, December 28-30, 1960.

P-2150. Criticality estimates for spheres and slabs. T. W. Mullikin. 12-1-60. Unclassified.

A discussion of the isotropic transport operator T for the neutron flux in a slab that is represented as an integral of a one-parameter family $T\mu$ ($0 \leq \mu \leq 1$) of compact self-adjoint operators whose spectral resolution is known. The operators "almost commute" in some sense, and this fact is used to estimate the eigenvalues of T , which give estimates of critical masses of spherical and slab reactors. A numerical example is given as evidence of the accuracy of these estimates. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, March 1961.

P-2151. Optimal sequencing of serial memory transfers. S. M. Johnson. 12-5-60. Unclassified.

A discussion of a problem, solved iteratively in a previous study, of finding an optimal sequence of word transfers on a serial memory drum. This paper presents an improved method that requires only a few simple adjustments after the initial trial sequence is formed. Mathematically it is of interest in that it is a special form of a traveling-salesman-type problem that can be easily solved. 9 pp. Illus.

P-2152. The irrationality of the zeros of the Bessel functions, J_0 and J_1 . O. A. Gross. 1-3-61. Unclassified.

A proof that if x is a positive (or negative) root of the equation $J_0(x) \cdot J_1(x) = 0$, then x is irrational, as well as x^2 . Moreover, if a is a rational number $\neq 0$, then $J_0(a)/J_1(a)$ is an irrational number. 9 pp.

P-2153. Standards, standardization, and test equipment. W. I. Rumer. 11-30-60. Unclassified.

An attempt to establish contexts and implications for the ambiguous terms "standards," "standardization," and "test equipment," as applied to Project ACE. The discussion of "standards" (the most general term) considers types, establishing authority, purpose, characteristics, and cost. The section on "standardization" examines effects on design, production, logistics, and training. The discussion on "test equipment" (the most specific term) considers its functions, purposes, errors, and effect on the prime equipment. 26 pp.

P-2154. New version of a two-organ chemotherapy model. B. Kotkin and J. A. Jacquez. 9-6-61. Unclassified.

A new version of the two-organ chemotherapy model discussed in P-2044, *Numerical Investigations of Chemotherapy Models*. A more direct expression of the analytic equations describing the physical process leads to a set of 19 differential-difference equations involving functions of t and $t - \tau$. It is necessary to store values only in the interval $(t - \tau, t)$ to obtain values of t in the range $(t, t + \tau)$. A new FORTRAN program was designed for the 7090 to solve these equations, and results were checked against previous solutions to verify the equivalence of the two models. The model was designed to incorporate either of two forms of the injection: an injection into the right side of the heart or an injection into the artery of one of the organs. 16 pp.

P-2155. What can managerial economics contribute to economic theory? C. J. Hitch and R. N. McKean. 12-1-60. Unclassified.

An examination of the potential feedbacks from management economics to economic theory, which are indicated in the form of improvements in production functions. The business behavioral inputs to economic theory are discussed, together with how managerial economics may affect these inputs. In addition, an attempt is made to develop a theory of government behavior to supplement the theory of the firm. 14 pp. Published in *American Economic Association Papers*, 1961. Presented before the American Economic Association at St. Louis, Missouri, December 28-30, 1960.

P-2156. Decisionmaking under uncertainty and problem solving: a Gestalt theoretical viewpoint. Nehemiah Jordan. 12-1-60. Unclassified.

A presentation of phenomena of thinking, problem-solving, and decisionmaking. The author asserts that this is the way men behave in situations necessitating this behavior. The phenomena are discussed using some simple topological terms at a very low level of abstraction. 38 pp. Illus.

P-2157. Determination of interplanetary transfer orbits for specified date of departure. H. B. Schechter. 12-1-60. Unclassified.

A method for determining heliocentric transfer ellipses for interplanetary missions which have a specified date of departure. The calculations can be performed in a few hours on a small desk computer and do not require the use of high-speed digital machines. A number of transfer orbits from Earth to Mars are computed for two arbitrarily selected dates of departure. The numerical results are summarized in a series of curves which display the characteristic velocity expenditures for trips of various durations, as well as the orientation of the departure velocity vector. 50 pp. Illus.

P-2158. The analysis and solution of optimum trajectory problems. S. E. Dreyfus.
12-9-60. Unclassified.

Alternatives to the conventional method of analysis and computational solution of optimal trajectory problems. References are made to papers containing fuller discussions of the techniques mentioned. 6 pp. Presented before the Symposium on Mathematical Optimization Techniques at Santa Monica, California, October 20, 1960.

P-2159. Preferential arrangements. O. A. Gross. 12-12-60. Unclassified.

A paper concerned with the total number of distinct rational preferences available to a person faced with n distinguishable decisions or objects, allowing indifference, with each object to be placed in exactly one indifference set. 11 pp. Published in the *American Mathematical Monthly*, January 1962.

P-2160. Positive ions in the lower D-region. F. R. Gilmore. 12-6-60. Unclassified.

A discussion of existing theories of the lower D-region of the ionosphere showing that the ionization is caused by cosmic rays and solar X-rays, which produce primarily N_2^+ and O_2^+ . This paper shows that reactions of these ions with the atmospheric oxygen and nitrogen molecules are probably fast enough to make NO^+ the predominant positive ion in this region. 4 pp.

P-2161. The role of the Chinese in Lao society. J. M. Halpern. 3-1-61. Unclassified.

An outline of some of the outstanding characteristics of the Chinese as an urban ethnic group, and an assessment of their economic role in the Lao economy. Throughout the countries of Southeast Asia, the overseas Chinese play a crucial role and in many cases a dominant one in commerce, industry, and banking. Since in most cases they constitute a minority of the total population and simultaneously stress their Chinese cultural identity, they pose a critical political problem to the self-conscious national states in this area that have gained their independence from Britain, France, and Holland since the end of World War II. 40 pp. Tables.

P-2163. On the fundamental equations of invariant imbedding—I. R. E. Bellman and R. E. Kalaba. 12-12-60. Unclassified.

A study of the connection between the transport equations for internal fluxes and the invariant imbedding equations for reflected fluxes for a one-dimensional transport process. Linearity of perturbation equations and the uniqueness of solution of a linear two-point boundary-value problem are the essential ingredients. In 1942 Ambarzumian showed how the energy diffusely reflected from a plane-parallel atmosphere can be calculated directly, i.e., without first determining the internal flux. This is done through the use of invariance principles which lead to nonlinear equations, as opposed to the usual linear transport equations for the internal fluxes. 8 pp. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, March 1961.

P-2166. Some thinking about "system." Nehemiah Jordan. 12-30-60. Unclassified.

An attempt to dispel some of the confusion about the term "system" and to show that the word is semantically legitimate per se, despite its many specific meanings. The author (1) reviews some obvious but neglected facts of perception and cognition, (2) explains the core meaning of the word "system," (3) tries to show that the many definitions of the term are correct applications of its core meaning to concrete cases, and (4) formulates a possible taxonomy of these applications. 31 pp.

P-2167. Economic natural selection and the theory of the firm. S. G. Winter, Jr.
12-19-60. Unclassified.

A discussion of the relationship between analysis of economic natural selection and direct theorizing about firm behavior. The natural selection argument cannot legitimately be invoked in support of any particular theory of the firm without study of the specific situations to which the theory is supposed to apply. In particular, if there is a strong case to be made for the conventional theory of the firm on economic natural selection grounds, it has yet to be made. On the other hand, those searching for a better theory of the firm will benefit from using the limited amount of guidance that economic natural selection considerations can offer. 21 pp. Presented before the Econometric Society at St. Louis, Missouri, December 28-30, 1960.

P-2169. Symmetric solutions of some general n -person games. J. von Neumann and O. Morgenstern. 3-2-61. Unclassified.

One step in the search for an exhaustive list of the solutions to a particular n -person game (namely, the game where all coalitions of $n-1$ players win, but all smaller coalitions lose). The game

has a unique solution that is symmetric with respect to all the players. It consists of all the imputations in which the number of players receiving any particular amount above the minimum is even. This paper (based on a 1946 manuscript) examines the class of solutions that are symmetric in just the first $n-1$ players. It breaks off after arriving at an interesting property of the payoffs to the n th player in any given solution of this class, to wit: any gap that may exist in the set of n th player payoffs cannot be wider than $(n-1-a)/(n-2)$, where a is the upper endpoint of the gap. In particular, the minimum payoff to the n th player is always less than $1/(n-1)$. This latter bound is known to be best possible, since solutions coming arbitrarily close to it can be constructed by Gillies' inflation techniques. 16 pp.

P-2170. Toward intelligent machines. J. D. Williams. 12-29-60. Unclassified.

The text of a talk given before the National Council of Teachers of Mathematics at Tempe, Arizona, December 29, 1960. Several reasons are discussed for optimism concerning the final outcome of the quest for intelligent machines. Man's hardware capabilities are substantial and are increasing swiftly. Machines are in existence that can help design more sophisticated machines. Such tools as statistical mechanics and experimental design that are pertinent to deliberate design are available. The author believes that man's development of extremely intelligent machines will probably be his greatest adventure. 11 pp. Published under "Science" in *Time* magazine, January 20, 1961.

P-2172. Meteoroid hazard to nuclear power stations in space. R. L. Bjork. 12-21-60. Unclassified.

An assessment of the meteoroid hazard to a nuclear power station operating in the vacuum of space. Such a station will require a radiator of large area. The radiator is the component shown to be most vulnerable to meteoroids in the sense that more weight is required to armor it properly than any other portion of the station. The radiator is indispensable, since the station must constantly rid itself of the heat created within it or else suffer the consequence of a continual temperature rise until intolerable levels are reached. 14 pp. Illus. A condensed version of P-1963. Published in *Nucleonics*, April 1961.

P-2173. Risk, ambiguity, and the Savage axioms. Daniel Ellsberg. August 1961. Unclassified.

A discussion of a class of situations in which many reasonable people neither wish nor tend to conform to the Savage postulates of rational behavior. There is no way to infer meaningful probabilities for events, even approximately or qualitatively, from their choices in these situations, nor can they be described as acting as if they were maximizing the mathematical expectation of utility, in terms of any probabilities whatever. None of the familiar criteria for predicting or prescribing decisionmaking under uncertainty corresponds to this pattern of choices. Yet the behavior is deliberate and orderly, and it can be described in terms of a simple, specified decision rule. Such self-consistent behavior violating the Savage axioms seems to occur in situations that can be described as highly ambiguous. In reaching a decision under these circumstances, many people seem to act conservatively. Without actually expecting the worst, they choose to act as if the worst outcomes were somewhat more likely than their best estimates of likelihood would indicate. 42 pp. Published in the *Quarterly Journal of Economics*, November 1961.

P-2174. On the uses of economics: theory, policy, and values. F. M. Bator. 2-9-61. Unclassified.

Emphasis on the highest function of normative economics, that of clarifying the issues and choices concerning the allocation of resources which are, or ought to be, the subject of national political debate. The study discusses the confusion among the public about the uses of economics in helping to make the grand choices of allocation, indicates the need for a precisely specified quantitative theory about the economy, and concludes with four possible strategies used for fulfilling the grand function of normative economics. 7 pp. Incorporated in *Research for Public Policy*, published by The Brookings Institute, Washington, D.C., 1961. \$2.50. Delivered at the ceremonies dedicating the Center for Advanced Study of The Brookings Institution at Washington, D.C., November 17, 1960.

P-2176. The public and private sectors and investment in Israel. Harold Lubell. 1-5-61. Unclassified.

A description of Israel's economy "as private enterprise financed out of the public budget." Although this statement is an exaggeration, it is shown to contain some elements of truth. The study discusses (1) the three major ownership groups in the country, i.e., private enterprises, public sector enterprises, and cooperatives; (2) output and investment by the public and private sectors; (3) public financing of investment; and (4) foreign aid and the financing of investment. 19 pp. Tables. Published in *Middle Eastern Affairs*, April 1961.

P-2177-1. The optimization of multi-stage orbit transfer processes by dynamic programming. F. T. Smith. 8-30-61. Unclassified.

An outline of the derivation of a set of variation of parameter equations by the use of Lagrange's brackets, which describe the perturbed motion of a space vehicle. These equations are integrated to obtain a set of state transformation equations which are used in conjunction with the method of dynamic programming to optimize a multi-stage orbit transfer process. Three special cases of the multi-stage process are discussed: a single-stage process, a two-stage process, and a special form of performance criterion. 27 pp. Published in the *ARS Journal*, November 1961.

P-2178. Note on the existence of perfect maps. I. S. Reed and R. M. Stewart. 1-3-61. Unclassified.

An attempt to determine location in a previously mapped region by map-matching. The question arises of minimum submap size relative to the size of the complete map of the region for unambiguous determination of position. A lower bound for the size of the submap is obtained for quantized binary maps. It is shown that there exist maps (called perfect) such that this lower bound is realized. Of special interest is the construction of a doubly periodic 4×4 perfect map for a 2×2 submap. 9 pp. Published in the *IRE Transactions on Information Theory*, January 1962.

P-2179-RC. The uses of economics. C. J. Hitch. 11-17-60. Unclassified.

The text of an address given at the ceremonies dedicating the Center for Advanced Study of The Brookings Institution at Washington, D.C., November 17, 1960. Ways are discussed in which economics can be useful (e.g., by providing an incisive and productive way of examining problems, by making the requisite economic analysis to improve choice among alternatives, and by designing institutional arrangements conducive to economy or efficiency). Both the traditional and the less traditional areas in the realm of public policy are described to show the type of problems in which economics can be useful. Finally, an attempt is made to determine how useful economists are and what can be done to make them more useful. 21 pp.

P-2180. Automatic indexing: an experimental inquiry. M. E. Maron. 2-2-61. Unclassified.

A description of the design, execution, and evaluation of a study aimed at testing empirically one statistical technique for automatic indexing. The technique considered automatically classifies documents according to their subject content. The task, in essence, is to have a computing machine read a document, and on the basis of the occurrence of selected clue words, decide to which of many subject categories the document in question belongs. 35 pp. An updated version of RM-2601. Published in the *Journal of the Association for Computing Machinery*, July 1961. Presented before the Third Institute of Information Storage and Retrieval at Washington, D.C., February 13-16, 1961.

P-2181. The present status of nonlinear programming. P. S. Wolfe. 1-12-61. Unclassified.

A survey of the so-called "primal" and "Lagrangian" methods for the solution of the convex, non-discrete mathematical programming problem. 30 pp. Illus. Presented before the Symposium on Mathematical Optimization Techniques at Santa Monica, California, October 18, 1960.

P-2182. On the iterative solution of two-point boundary value problems. R. E. Bellman. 1-18-61. Unclassified.

A discussion of the problem of solving $x'' + A^2x = 0$, $x(0) = c$, $x(1) = d$, which can be solved in a straightforward fashion involving the solution of a system of linear algebraic equations. It is

shown that this can be avoided by the use of a simple iterative scheme involving only the solution of linear differential equations, and a minimum of storage of values. 9 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 16, No. 3, 1961.

P-2183. The crude analysis of strategic choices. Daniel Ellsberg. 12-15-60. Unclassified.

A discussion of some major, interrelated elements in two concurrent U.S. and Soviet decision problems, namely, whether or not to launch an all-out nuclear attack on the opponent. "Strike" denotes such an attack. The "wait" strategy may be interpreted either as a representative or as a best alternative to strike. Eight variables are examined in this schema. While the model can by no means be considered adequate for comparing U.S. military alternatives, it may represent a minimum framework which is an advance over single-variable models implicit in much current discussion. 13 pp. Published in *The American Economic Review*, May 1961. Presented before the American Economic Association at St. Louis, Missouri, December 28, 1960.

P-2184. Complements and substitutes in the optimal assignment problem. L. S. Shapley. 1-9-61. Unclassified.

A study of the "optimal assignment problem" as a process that depends intricately on several input activities. The complementarity-substitutability relationships between its elements are established, i.e., whether the relationships reinforce or interfere with each other's influence on the process as a whole. It is shown that in a standard interpretation of the problem, man-machine pairs are complementary, while man-man and machine-machine pairs are substitutes. 7 pp. Illus. An updated version of RM-2240. See companion piece P-2185. Published in the *Naval Research Logistics Quarterly*, March 1962.

P-2185. On network flow functions. L. S. Shapley. 1-9-61. Unclassified.

An investigation of the capacity of a network as a function of the capacities of its individual arcs. The case of two variable arcs is studied in detail. It is found that each pair of arcs either consistently help each other or consistently hinder each other. Interaction types are computed for a number of special cases (e.g., arcs in parallel and arcs in series). 16 pp. Illus. Also published as RM-2338. See companion piece P-2184. Published in the *Naval Research Logistics Quarterly*, June 1961. Presented before the Symposium on Mathematical Programming at Santa Monica, California, March 16-20, 1959.

P-2186. The compression of finite discrete messages. M. B. Marcus and I. S. Reed. 12-22-60. Unclassified.

A discussion of the compression problem for codes of finite length. Methods are presented for evaluating codes devised for the transmission of messages of limited duration. 15 pp. Table.

P-2187. An optimum thrust control problem. L. D. Berkovitz. 1-6-61. Unclassified.

A study of the thrust program that maximizes the velocity at burnout of a rocket fired upwards from rest and subject to a quadratic drag. The thrust program is shown to consist of maximum thrust for the entire controlled flight. The principal tool used is a theorem on control processes that can be easily derived from the theory of the Bolza problem in the calculus of variations. 20 pp. Published in the *Journal of Mathematical Analysis and Applications*, August 1961.

P-2189. Quasilinearization and upper and lower bounds for variational problems. R. E. Bellman. 1-11-61. Unclassified.

An indication of how the technique of quasilinearization can be used in a number of cases to provide both a minimum and a maximum problem, starting with merely one or the other. The technique is applied to the simplest type of variational problem. Since most variational problems are analytically intractable, recourse must be had to approximate techniques if numerical results are desired. One of the most useful devices is that of writing the desired extremum as both a minimum of one quantity and a maximum of another. In this way both upper and lower bounds are obtained and, in addition, estimates of the accuracy of approximation. 7 pp. Published in the *Quarterly of Applied Mathematics*, January 1962.

P-2190. A note on an inverse problem in mathematical physics. R. E. Bellman and J. M. Richardson. 1-11-61. Unclassified.

An investigation of inverse problems associated with the linear partial differential equation of diffusion theory and heat conduction,

$$\psi(x) \frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2},$$

subject to appropriate initial and boundary conditions. An attempt is made to show how inverse problems of this nature are closely related to some classical synthesis problems for electrical networks. The new approach considered furnishes a way of obtaining approximate solutions which appears to be more useful from the computational, engineering, and physical standpoint than the exact solutions furnished implicitly by the methods of Borg, Gelfand, and Levitan. 9 pp. Published in *Quarterly of Applied Mathematics*, October 1961.

P-2191. Some experiments and problems in mathematical biology. E. C. De Land. 4-18-61. Unclassified.

Some examples of mathematical models which serve to illustrate present problems in mathematical biology. A biological system is defined as a complete, closed, integral collection of tissues and fluids, of whatever complexity, whose inputs, outputs, and functions are describable. A mathematical model in biology is defined as a set of mathematical equations and boundary conditions which describe a system from biology whose solutions describe the behavior or condition of that system. Model building is designed to obtain a realistic simulation within well-defined (repeatable) boundary conditions which will facilitate analysis and understanding of complex systems. 17 pp. Illus. Presented before the Symposium on Biomedical Engineering at San Diego, California, April 20 and 21, 1961, and published in the proceedings of the Symposium.

P-2192. Impact wave propagation in columns of sand, part II. B. R. Parkin. 1-11-61. Unclassified.

A theoretical study of impact wave propagation in dry sand. Mathematically, the sand is treated as a strain-rate sensitive elastic-plastic material. Results from this theory are compared with elastic and elasto-plastic theories of wave propagation. Appropriate similitude parameters are discussed, and the impact response of drum-type pressure gauges is considered. 34 pp. Illus. For part I of this study, see P-2004-1. Published under the title, "Impact Waves in Sand: Implications of an Elementary Theory," in the *Journal of the Soil Mechanics and Foundations Division, Proceedings of the American Society of Civil Engineers*, August 1961.

P-2193. The upper atmosphere as observed with rockets and satellites. W. W. Kellogg. 1-13-61. Unclassified.

A discussion of the motions and temperature distributions in the upper atmosphere below 100 km, which have been measured by rockets fired over a wide range of latitudes during and subsequent to the IGY. It is evident that the atmosphere above the levels attainable by balloons is complex, and that disturbances in the upper atmosphere are probably the source of effects noted lower down. Some of these effects are summarized, and some relationships are traced between solar activity and some well-known geophysical phenomena. 15 pp. Illus. Presented before the School of Aviation Medicine at Brooks Air Force Base, Texas, as part of its "Lectures in Aerospace Medicine," January 16, 1961, and published in the proceedings of the Meeting.

P-2194-RC. Another small problem in the analysis of growth. B. F. Massell. 1-13-61. Unclassified.

A study discussing the evidence that the observed increase in the average productivity of labor has been primarily a consequence of technical progress, as contrasted with capital deepening. However, H. S. Levine in a recent article maintains that the problem of apportioning increases in labor productivity between technical progress and capital deepening is mathematically insoluble. This paper (1) indicates another procedural difficulty involved in the apportionment of productivity increase between the two components and (2) presents a partial solution to the problem. 9 pp.

P-2195. A simulation model for data system analysis. Leon Gainen. 3-1-61. Unclassified.

An attempt to promote the use of simulation techniques for the analysis of data systems that have been designed for management information processing. A technique of simulating dynamic system operation with a generalized data system model is described to provide the data system designer with insights on the behavior to expect from the data system as it would operate. Some of the benefits made possible through such simulation are explored. It is concluded that at present the major use of this analytical technique is to test the feasibility of a data system design before acquisition of actual hardware. 19 pp. Illus. Presented before the Eastern Joint Computer Conference at Washington, D.C., December 13, 1961, and published in the proceedings of the Conference.

P-2197. The nature of data in language analysis. T. W. Ziehe and S. L. Marks. 1-17-61. Unclassified.

A discussion of a variety of relationships exhibited by data used for, and resulting from, the analysis of languages. Both the data and the relationships are subject to frequent modifications. The method described for organizing these data is a generalized notation for expressing the structure of the data. The notation shows the relationships among data of a data class and the relationships among data classes. These expressed relationships are kept separate from computer routines and are made a part of the data. This separation is viewed as an aid to both linguist and programmer. 18 pp. Illus.

P-2199. Four types of learning: a phenomenological analysis. Nehemiah Jordan. 1-19-61. Unclassified.

A treatment of "learning" at a relatively low level of abstraction. The study focuses on learning processes immediately abstracted from the phenomena given, leaving open the more basic question of whether there is a unique process underlying all learning phenomena or not. It discusses a learning process found in the developing child, called "maturational learning," which is not found in an adult. In addition, the author considers three learning processes common to children and adults: learning to do things, acquiring knowledge, and learning to get along with people or in groups. 28 pp.

P-2200. Some numerical experiments using Newton's method for nonlinear parabolic and elliptic boundary-value problems. R. E. Bellman, M. L. Juncosa, and R. E. Kalaba. 1-23-61. Unclassified.

A numerical solution to a nonlinear parabolic equation of the form $u_t - u_{xx} = g(u)$, and a nonlinear elliptic equation $u_{xx} + u_{yy} = e^u$, using a generalization of Newton's method. Comparison of these results with results obtained using the Picard iteration procedure show that in many cases the quasilinearization method offers substantial advantages in both time and accuracy. 19 pp. Tables. Published in the *Communications of the Association for Computing Machinery*, April 1961.

P-2201. Directions for future growth of the Soviet economy. J. A. Kershaw. 1-23-61. Unclassified.

A description of the consistent and high rate of growth of the Soviet economy since 1929 in an attempt to determine its future general trend. The problems of the agricultural sector of the Soviet economy are compared to the success of the industrial sector. The impact of competition from other sectors of the economy on the rate of growth is discussed (namely, foreign aid, national defense, higher living standards, and deficiency in the rate of growth of the labor supply in Soviet cities). With increasing interest focused on the economic performance of East and West, the relative growth rates of the two will play a significant role. 20 pp. Incorporated in *Russian and East European Series—Vol. 25: Study of the Soviet Economy*, published by the Indiana University Press, Bloomington, Indiana, 1961. \$3.00. Presented before the University of Indiana Conference on the Study of the Soviet Economy at Bloomington, Indiana, February 3-4, 1961.

P-2202. Invariant imbedding and random walk. R. E. Bellman. 1-24-61. Unclassified.

An extension of P-1113, P-1614, and P-1858, which discuss the classical random walk process using the theory of invariant imbedding. This paper applies the functional equation technique to the case where several steps can be taken in either direction. 9 pp. Published in the *Proceedings of the American Mathematical Society*, April 1962.

P-2203. The economics of compensating balances. Egon Neuberger. 1-25-61. Unclassified.

An analysis of various aspects of compensating balances in the monetary system. Those aspects considered are (1) the general types of compensating balances, (2) specific examples of these balances, (3) some quantitative evaluation of their size, (4) the advantages and disadvantages of these balances, and (5) the effect their existence has on the effectiveness of monetary policy. It is concluded that compensating balances of various types exist in our economy, that they have significant effects on both cyclical and secular changes in the velocity of turnover of demand deposits, and that they influence the effectiveness of monetary policy measures. 33 pp. Illus.

P-2205. A variational approach to differential games. L. D. Berkovitz. 11-1-60. Unclassified.

A study of a class of differential games having pure strategy solutions, using results and techniques from the calculus of variations. These games are related to two Bolza problems with differential inequalities as added side conditions. Necessary conditions that must hold along an optimal path are derived from the theory of the related Bolza problems. These conditions are (1) a multiplier rule, together with transversality conditions and jump conditions, (2) a local min-max condition that is related to the Weierstrass condition, and (3) an analogue of the Clebsch condition. The continuity and differentiability properties of the value of the game are derived, and it is shown that wherever the value is differentiable, it satisfies an analogue of the Hamilton-Jacobi equation. Sufficient conditions are given in terms of the notion of a field and a local min-max condition. 83 pp. Illus. Also published as RM-2772.

P-2206. Some linguistic problems of Russian graphic abbreviations. W. A. Stewart. 1-26-61. Unclassified.

A discussion of the problems posed by abbreviations in the machine translation of Russian texts on scientific or technical subjects. Since some abbreviations represent strings of full-form occurrences, there exists the possibility of dealing with them either as unit morphs or as phrases. Also, since the grammatical suffix which normally serves as a syntactical marker in Russian is usually dropped in forming abbreviations, the question of ascertaining the syntactical relationships of a given abbreviation with its environment must be solved by other means. 14 pp.

P-2207. Asymptotic behavior of the total cost function for dynamic inventory processes. D. L. Iglehart. 9-9-60. Unclassified.

A paper which demonstrates a relationship between inventory control problem solutions obtained in the steady-state approach and those by the functional equation route. Under certain conditions on the cost functions, the average cost per stage of an N -stage inventory process, using an optimal ordering policy, converges as N goes to infinity to a constant that is the minimum steady-state cost per stage for policies determined by a single parameter. 16 pp.

P-2208. The trade agreements of Communist China. C. F. Remer. 2-1-61. Unclassified.

A paper on the nature and significance of the trade agreements of Communist China. The author examines the provisions of the trade agreements, their relation to other international economic agreements, the available but incomplete statistics of the trade of Communist China, and what is known about the history of the agreements and the policies associated with them. The economic aspects of the trade agreements are emphasized, rather than the political or military aspects. 132 pp.

P-2209. Energy policy and security of energy supply in Western Europe. Harold Lubell. 2-1-61. Unclassified.

A discussion of the shift in Western European energy policy from coal to overseas oil. The economic argument in favor of this change is that it is cheaper for the economy to obtain its energy from abroad than to produce it at home. The political argument against it is that of security of supply. Although oil supplies are vulnerable to disruption because of political action by the producing country, many of the energy experts in Europe are convinced that increased diversification of overseas sources of supply provides sufficient security of supply. The main criticisms of the experts' view are that the cost argument is overplayed, that freedom of consumer choice is really only a catchword, and that the security aspect is underplayed. 56 pp. Tables. Published in *World Politics*, April 1961.

P-2210. Computational considerations for some deterministic and adaptive control processes. R. E. Kalaba. 1-17-61. Unclassified.

A discussion of design and utilization considerations in the fields of guidance and control which lead to problems in the calculus of variations and dynamic programming. The resulting equations are frequently so complex that modern digital computers must be used in their resolution. It is shown that the quasilinearization method discussed in P-1163 can be used effectively to deal with some nonlinear Euler equations and their associated boundary values. It is also shown that the concepts of dynamic programming provide natural tools for the formulation and numerical solution of some adaptive control processes such as occur in sequential detection schemes in radar and communication. 40 pp. Table. See also P-1163.

P-2211. Principles of invariance in transport theory. T. W. Mullikin. 1-30-61. Unclassified.

A study of the transfer of radiation in a plane parallel atmosphere with a general nonisotropic phase function which can vary with depth in the atmosphere. The linear transport equation is used to prove the existence and uniqueness of a solution to the transport problem and to prove that this solution satisfies the "principles of invariance" of Chandrasekhar. Thus, these principles are derived within the framework of the transport equation. 24 pp. Published in the *Journal of Mathematical Analysis and Applications*, December 1961.

P-2212. Load moving with super-seismic speed over a layered elastic solid. J. L. Sackman. 10-12-60. Unclassified.

An investigation of the displacements and stresses produced in a two-layered elastic half space by the uniform motion of a concentrated normal line load along the surface of the half space. It is assumed that the speed of the load is greater than the velocities of propagation of dilatational and distortional waves in either layer (super-seismic case). It is further assumed that the load has been moving steadily for a long time so that a steady state (of plane strain) exists with respect to a coordinate system attached to the moving load. The solution resulting from a steadily moving arbitrary load distribution can be obtained by superposition of the line load solution, and results are shown for a pressure distribution varying as the unit step function. 11 pp. Illus.

P-2213. A new interpretation of the structure and CO₂ content of the Venus atmosphere. L. D. Kaplan. 5-2-61. Unclassified.

An attempt to estimate the cloud-top temperature in the Venus atmosphere and to put limits on the cloud-top pressure and the CO₂ concentration. The outstanding facts about Venus are that its surface is obscured by an almost uniform cloud or haze layer of unknown thickness, and that it contains a large amount of CO₂. The results show a cloud-top temperature of about 235°K., a cloud-top pressure of about 140 mb, and a CO₂ concentration of about 20 per cent by volume. 18 pp. Illus. Published in *Planetary and Space Science*, October 1961.

P-2214. Laos: the current phase in a cyclic regional revolution. A. M. Jonas and G. K. Tanham. 2-2-61. Unclassified.

A discussion of cyclic regional revolution (defined as a conflict technique which, in accordance with international communism, exploits national liberation movements). This technique, better than any other, minimizes the jeopardy to the Soviet Union's simultaneous efforts to realize coexistence and negotiate with the United States at the highest level. 19 pp. Published in *Orbis*, Spring 1961.

P-2215. An extension of the Karal-Keller asymptotic theory of wave propagation and its application to explosive sources. H. A. Lang. 1-12-61. Unclassified.

A simplification of the Karal-Keller theory to make the results of diffraction studies more directly applicable to seismic problems. The theory is applied to an explosive source in a spherical cavity where it becomes exact because the displacement series terminates after two terms. This solves the source problem as a necessary step in considering both free surface reflection in a homogeneous media and propagation in inhomogeneous media. 22 pp. See also P-1498, P-1650, P-1755, and P-2054.

P-2216. The economic potential of communication satellites. W. H. Meckling. 3-1-61. Unclassified.

A discussion of communication satellites as a promising means of substantially reducing cost as compared to the new submarine cables, provided high rates of use can be achieved. The real question therefore is demand: just how soon will demand be sufficient to support such systems. Judging from the experience of the 1930's and more recent experience when submarine telephone cables were put in operation, the author believes that lower toll rates would lead to a substantial expansion of use. New kinds of demand are a second important factor, but their potential is difficult to evaluate. 26 pp. Illus. Published in *Science*, June 16, 1961.

P-2217. Economic aid reconsidered. Charles Wolf, Jr. 2-14-61. Unclassified.

Comments on Professor Milton Friedman's article "Foreign Economic Aid: Means and Objectives" (published in *Yale Review*, Summer 1958). The article states that "despite the intentions of foreign economic aid, its major effect, insofar as it has an effect at all, will be to speed the communization of the underdeveloped world." This paper dispels some of the general arguments against foreign economic aid which are advanced by Friedman. Reasonable objectives of foreign economic aid are suggested, as well as its distinct limitations as a means of accomplishing other objectives. 22 pp. Published in *The Yale Review*, Summer 1961.

P-2218-1. Thermodynamic properties of carbon dioxide to 24,000° K. J. L. Raymond. September 1961. Unclassified.

A study of the properties of 100 per cent CO₂ in the temperature range of 1000° K to 24,000° K and pressure range of 10⁻⁴ to 10⁻² atmospheres. The properties calculated are enthalpy, entropy, molecular weight, density, internal energy, and molar composition. A Mollier chart for 100 per cent CO₂ in these ranges is presented. This paper should be of interest to those concerned with aerodynamic problems of entry into the Venusian atmosphere, which may consist of CO₂ by weight. 17 pp. Illus. An abridgment of RM-2292. Published in the *Journal of Chemical and Engineering Data*, April 1962.

P-2219. On capital theory and development planning. F. M. Bator. 2-10-61. Unclassified.

Comments on a paper by Professor Otto Eckstein, prepared for the December 1960 meeting of the American Economic Association at St. Louis, Missouri, and published in the *American Economic Review, Papers and Proceedings*, May 1961. The author and Eckstein are both bearish about the usefulness of capital theory to the development planner, but for somewhat different reasons. 8 pp.

P-2220. Democratic stability and instability. Paul Kecskemeti. 2-10-61. Unclassified.

A discourse on the many hazards confronting democracies. Some feel that the hazards are only temporary, that the trend of urbanization, industrialization, and modernization is irresistible, and that this trend will eventually create that social and cultural climate in which Western democracy can flourish. However, the ultimate question is whether, on the arduous road of material progress, people's needs of self-expression will be sustained by a democratic state symbolism. With competing state symbols of great suggestive force, democracy cannot prevail unless the potentially divisive and debilitating effects of its basic principle (namely, popular control over political decisions) are overcome by a unifying expressive symbolism. 15 pp. Published in *Social Research*, Summer 1961.

P-2221. Modeling human mental processes. H. A. Simon. 2-20-61. Unclassified.

A talk presented before the Western Joint Computer Conference at Los Angeles, California, May 1961, and published in the proceedings of the Conference. At least a half dozen computer programs exist that simulate some of the information processes that humans use to perform problem solving, learning, perceiving, and thinking tasks. These programs constitute theoretical explanations of the corresponding human behavior, and can be tested by comparing the computer traces they produce with the verbal behavior of subjects in the psychological laboratory. This paper surveys this new kind of theory building and theory testing in psychology, and relates it to other uses of simulation as a tool of psychological research. 25 pp.

P-2222. New tools for planners and programmers. David Novick. 2-14-61. Unclassified.

A discussion of conditions which make current machinery inadequate for handling problems involved in U.S. security planning and of new tools which can meet the needs of the planners and decision-

makers. While in no sense a panacea, these new tools should facilitate dealing with the uncertainty of defense fund requirements in the nuclear-rocket-space age. With an understanding of the potential decision points available, together with time-phased resource impacts of new systems, it should be possible to avoid the necessity of delays in important programs and of cancellation of others. 21 pp. Tables. Published in *The Executive*, September 1961.

P-2223-1. Simulation and long-range planning for resource allocation. R. M. Rauner and W. A. Steger. 3-15-61. Unclassified.

Part of a broader investigation concerned with the development of a method of large-scale, manned simulation and with its application to some allocation problems faced by long-range planners in Air Force logistics organizations. This paper describes one of the major simulations RAND has conducted and suggests ways in which this research technique might bear upon allocation theory and practice. It is concluded that manned simulations appear promising to those planners who must choose between alternative resource allocations as they design complex systems in which man plays some kind of managerial role. 33 pp. Illus. Published in *The Quarterly Journal of Economics*, May 1962.

P-2224. Correlation of rock properties by statistical methods. W. R. Judd and C. R. Huber. 2-14-61. Unclassified.

A statistical approach for correlating physical properties of rocks. Geological considerations are minimized, and the approach is based on a comparison of fourteen physical properties of rocks (i.e., apparent specific gravity, per cent porosity, scleroscope hardness, abrasive hardness, specific damping capacity, moduli of rigidity and rupture, static and dynamic moduli of elasticity, compressive strength, impact toughness, longitudinal velocity of sonic wave propagation, tensile strength, and Poisson's ratio). This paper deals with the "problem finding" or "debugging" phase in the use of computer and statistical methods for rock analysis that may ultimately determine equations for predicting the physical properties of rock within a relatively narrow and thus useful range. 40 pp. Illus. Incorporated in *International Symposium on Mining Research*, ed. by G. B. Clark, published by Pergamon Press, New York, 1962. \$30.00. Presented before the International Symposium on Mining Research, University of Missouri School of Mining and Metallurgy, Rolla, Missouri, February 21-25, 1961.

P-2225. On the approximation of curves by line segments using dynamic programming. R. E. Bellman. 2-16-61. Unclassified.

The title of this paper adequately describes its content. 6 pp. Published in the *Communications of the Association for Computing Machinery*, June 1961.

P-2226. Production functions and capital depreciation. Stephen Enke. 2-16-61. Unclassified.

A discussion of macroeconomic theory, which has during recent decades tended to stress the determination and distribution of net income. Various production functions have in turn been used that do not handle capital stock depreciation explicitly and yet purport to determine net incomes directly. The moral of this essay is that production functions that include capital stocks as an input can only be output equations because of the nature of capital's contribution to production. Such output statements are independent of depreciation. These fundamental economic concepts may have been more thoroughly understood a hundred years ago than today. 21 pp. Illus.

P-2227. Rocket probes in the upper atmosphere. W. W. Kellogg. 2-17-61. Unclassified.

A discussion of the effect of rocket probes on modern meteorology. What is known of the mesosphere and the stratosphere gives promise of interesting yet-to-be-discovered relationships between the phenomena at these levels and the weather and climate near the surface of the earth. A rocket-probe program that is extensive as well as intensive is required if these relationships are to be defined. 16 pp. Illus. Published in the *Bulletin of the Atomic Scientists*, May-June 1961.

P-2229. General Nasution's mission to Moscow. G. J. Pauker. 2-27-61. Unclassified.

A discussion of the events prior to President Sukarno's visit to Washington. The paper emphasizes that this trip may offer an opportunity to the Kennedy administration to check what appears to be an alarming trend in Indonesia's world orientation. While the West was preoccupied with Cuba, Laos, and the Congo, the Soviet Union has been quietly setting the stage for a major political victory in Indonesia. Despite a slow start in achieving influence in Djakarta, the Soviet Union has exploited with tenacity and realism Indonesia's frustrations concerning the achievement of its major

national goals and has been betting heavily, of late, on the possibility of a rapprochement. 16 pp. Published in *Asian Survey*, March 1961.

P-2230-1. The foreign policy uses of the Chinese revolutionary model. A. M. Halpern. 8-28-61. Unclassified.

An exploration of the contribution of the analysis of overt communication to the understanding of the political processes of a closed society. Specifically, the study examines the way Chinese Communists have represented the significance for others of their experience in achieving power by revolutionary means. Events since their formally coming to power in 1949 are explained in terms of their doctrine for revolutionary success (namely, a Leninist party serving as the vanguard of the proletariat, a revolutionary army controlled by the party, and a "correct" policy concerning the united front). 28 pp. Published in *The China Quarterly*, July–September 1961. Presented before the Association of Asian Studies at Chicago, Illinois, March 27, 1961.

P-2232. Operators commuting with translation by one: part I—representation theorems. D. C. McGarvey. 2-22-61. Unclassified.

A representation of operators in $L_2(-\infty, \infty)$ which commute with translation by one in terms of $L_2(0, 1)$ operator valued functions of θ , $0 \leq \theta < 2\pi$. In a subsequent study, this representation is used to employ perturbation techniques, heretofore applicable only to operators with compact resolvents, to nonself adjoint differential operators with periodic coefficients on $L_2(-\infty, \infty)$, and to give conditions on the coefficients of these operators which ensure that they be spectral (completely reducible) even though they have continuous spectrum. 74 pp. For Part II, see RM-2906-PR.

P-2233. On the computational solution of a class of nonlinear differential-difference equations. R. E. Bellman and B. Kotkin. 2-27-61. Unclassified.

A re-examination of the proof that the computational solution of differential-difference equations of a certain form can be made to depend on the computational solution of a related system of ordinary differential equations. This reduction is important, because in certain favorable cases it eliminates memory problems which can become formidable for multidimensional systems. Existing programs can also be used for differential equations of proven worth. This paper studies a particular equation with some interesting properties which arises in fields ranging from mathematical economics to population growth to number theory. 15 pp. Illus.

P-2234. The use of manned simulation in the weapon system planning process. M. A. Geisler and W. A. Steger. 2-28-61. Unclassified.

A description of the benefits and disadvantages of manned simulation as part of the over-all weapon system planning process. The basic assumption underlying this application of the technique is that management is an important part of a complex weapon system and that no other technique can produce the kind of information about the management system that weapon planners require in making their myriad decisions. Numerous problems remain, however, and research is being continued at RAND to help improve the usefulness of the technique. 21 pp. Published in *Operations Research*, September–October 1961.

P-2235. The simulation of verbal learning behavior. E. A. Feigenbaum. 3-1-61. Unclassified.

A description of an information processing model of elementary human symbolic learning as a computer program, called Elementary Perceiver and Memorizer (EPAM). The program simulates the behavior of subjects in experiments involving the rote learning of nonsense syllables. A discrimination net which grows is the basis of EPAM's associative memory. Fundamental information processes include processes for discrimination, discrimination learning, memorization, association using cues, and response retrieval with cues. Many well-known phenomena of rote learning are to be found in EPAM's experimental behavior, including some rather complex forgetting phenomena. EPAM is programmed in Information Processing Language V. 30 pp. Illus. Presented before the Western Joint Computer Conference at Los Angeles, California, May 9–11, 1961, and published in the proceedings of the Conference.

P-2236-1. RAND: the history, operations, and goals of a nonprofit corporation. J. R. Goldstein. April 1961. Unclassified.

A talk presented before the Harvard Business School Alumni at the University Club, Los Angeles, California, February 23, 1961. The paper discusses Project RAND's beginning and its establishment

as an independent organization. The administrative and technical organization of RAND is described, along with some of its significant contributions to research. In addition, RAND's many goals are examined, its most important goal being the survival of our way of life. 26 pp.

P-2237. Dynamic programming treatment of the traveling salesman problem. R. E. Bellman. 3-1-61. Unclassified.

A discussion of the well-known traveling salesman problem: "A salesman is required to visit each of n different cities, starting from a base city and returning to this city. What path minimizes the total distance traveled by the salesman?" It is shown that this problem can easily be formulated in dynamic programming terms, and resolved computationally for up to seventeen cities. For larger numbers, the method presented can be used to obtain quick approximate solutions. 7 pp. Published in the *Journal of the Association for Computing Machinery*, January 1962.

P-2239. The analysis of some essential considerations in program design of real-time control systems. L. J. Craig. 3-9-61. Unclassified.

Some considerations in the program design of real-time systems presented in terms of sampled-data feedback control theory. An example of the control of a second-order linear system is given, and the effects of the sampling-desampling (input-output) rate, the compensator (routine) design, and the transport lag (time delay) are examined for their effects on the system performance. It is shown that the design of an "optimal" routine for a control function may result in extremely poor system performance if the specifications for the timing are not rigidly adhered to. The author believes that the methodology provided for synthesizing the time-wise adaptive program structure will increase the use of digital machines in real-time control processes. 41 pp. Illus. Presented before the Control Systems Seminar at Santa Monica, California, February 15, 1961.

P-2240. College admissions and the stability of marriage. D. Gale and L. S. Shapley. 3-3-61. Unclassified.

A procedure for assigning applicants to colleges which removes all uncertainties and, assuming there are enough applicants, assigns to each college precisely its quota. To determine the existence of stable assignments, the authors discuss whether it is possible, for any pattern of preferences, to find a stable set of marriages. It is shown that the extension of the "deferred acceptance" procedure to the problem of college admission yields not only a stable but an optimal assignment of applicants. 18 pp.

P-2241. Interrupted stochastic control processes. R. E. Bellman and R. E. Kalaba. 3-7-61. Unclassified.

A discussion of an interrupted stochastic control process, i.e., a given discrete stochastic control process with the added feature that there is a chance at any particular stage that the true state of the system will not be known to the decisionmaker. Processes of this type possess interesting and novel aspects and present some complex analytic and computational questions. 7 pp. Published in *Information and Control*, December 1961.

P-2243. On the reduction of dimensionality for classes of dynamic programming processes. R. E. Bellman. 3-7-61. Unclassified.

A technique which appears quite promising in obtaining an accurate solution to a particular basic functional equation of dynamic programming. The applicability of the technique is indicated in a method of successive approximations applied to processes of very high dimension, and to the digital computer determination of optimal play of chess and checkers. 5 pp. Published in the *Journal of Mathematical Analysis and Applications*, October 1961.

P-2244. Ionization trails. P. S. Lykoudis. 3-7-61. Unclassified.

A review of the basic equilibrium and nonequilibrium aspects of hypersonic trails. In the case of thermodynamic equilibrium, a universal solution is found for the velocity and enthalpy distributions at a station behind the body where the pressure has reached its ambient free-stream value. Available solutions found numerically through the method of characteristics are in good agreement with the theoretical results. The thermal-conduction part of the trail is studied. A closed-form solution is found for variable thermal conductivity. The length of the trail based on a minimum ionization level is calculated for an actual re-entry at different altitudes. The influence in the conduction part of the trail of the trailing shock is discussed. In addition, the trail under chemically frozen conditions is

examined. 24 pp. Illus. Published in the *Proceedings of the 1961 Heat Transfer and Fluid Mechanics Institute*, 1961.

P-2246. The role of data input in automatic data processing systems. S. L. Pollack. 3-9-61. Unclassified.

A discussion of data input which is generally considered after the computer system has been developed. This paper contends that data-input problems can be dealt with most effectively if data-input techniques and equipment are made integral parts of an electronic data processing (EDP) system. Plans for data-input equipment and techniques should be developed concurrently with those for the EDP equipment and system design. The newer data-input techniques, such as character recognition by optical sensing or transmission of digital information over phone lines, can best be exploited if their use is considered while the data processing system is being designed, rather than being added as bits and pieces. 13 pp. An abridgment of RM-2681. Published in the *Journal of Machine Accounting*, September 1961.

P-2248-1. Soviet capital on January 1, 1960. N. M. Kaplan. October 1961. Unclassified.

A discussion of the Russian inventory and revaluation of capital (i.e., of buildings, structures, producers' durables, and other fixed assets in place), undertaken in the last four months of 1959. This paper attempts (1) to describe the revaluation procedures; (2) to present and comment on the primary results, the 1960 capital values; and (3) to draw some implications from the results, primarily some intertemporal and international comparisons of the distribution of capital. 110 pp. Tables. Presented before the Conference on Economics of Soviet Industrialization at Princeton, New Jersey, May 6-8, 1961.

P-2249. VLF ionospheric reflection coefficients: derivation from impedance concepts and values for some model ionospheres. P. Tamarkin and E. C. Field, Jr. 1-30-61. Unclassified.

A method for computing the reflected wave excited by an arbitrarily polarized, plane, very low frequency electromagnetic wave incident at an arbitrary direction upon a sharply bounded, absorptive ionosphere in the geomagnetic field. The results of calculations for eight model ionospheres are given in the form of graphs of reflection coefficient amplitude and phase versus angle of incidence for both East-West and West-East propagation at 16 kc/sec. The model ionospheres are characterized by values of electron density and collision frequency. 23 pp. Illus. See companion piece P-2409. Published in the *Journal of Geophysical Research*, September 1961.

P-2251. On variation-diminishing properties of Green's functions. R. E. Bellman. 3-14-61. Unclassified.

An attempt to determine the variation-diminishing property of Green's function $K(x, y)$. The method followed is that used for obtaining the absolute minimum $J(u)$ contained in a particular related quadratic form. 4 pp. Illus. Published in the *Bollettino della Unione Matematica Italiana*, Vol. 16, No. 3, 1961.

P-2252. Decisionmaking for public investment: discussion. J. W. Milliman. 1-15-61. Unclassified.

Research bearing on two papers which deal with decisionmaking for public investment and which were presented at the December 1960 joint session of the Econometric Society and the Regional Science Association in St. Louis, Missouri. The papers are "Welfare Aspects of Benefit-cost Analysis," by John M. Krutilla, and "Water and Welfare," by Robert Dorfman. In the light of these papers, the author comments on the RAND-sponsored study *Water Supply: Economics, Technology, and Policy*, by Hirschleifer, DeHaven, and Milliman (University of Chicago Press, 1960). 12 pp. Presented before the joint meeting of the Econometric Society and the Regional Science Association at St. Louis, Missouri, December 30, 1960, and published in the proceedings of the Meeting.

P-2253-1. Estimates of critical dimensions of spherical and slab reactors. T. W. Mullikin. 8-25-61. Unclassified.

A paper concerned with determining the critical mass of spherical and slab reactors, a problem which is equivalent to determining two of the eigenvalues of a linear integral operator T . This same operator is important in the theory of radiative transfer in homogeneous plane parallel atmospheres with isotropic scattering, where it is known as the truncated Hopf operator. T is repre-

sented as the integral of a one-parameter family T_μ ($0 \leq \mu \leq 1$) of compact, positive definite, self-adjoint operators whose spectral resolutions can be explicitly computed. This representation proves immediately the compactness and positive definiteness of T . It provides upper and lower bounds on the two largest eigenvalues of T . The theory also applies to stratified slab and spherical reactors where the physical properties can change from strata to strata. This is developed and then applied to reactors with a homogeneous core surrounded by a homogeneous reflector. Numerical results are given for the bare homogeneous reactors. 26 pp. Tables.

P-2254. Current communist tactics in Indonesia. G. J. Pauker. 4-4-61. Unclassified.

A discussion of current communist tactics in Indonesia which shows no immediate danger of a communist coup in Indonesia. The likelihood of an ultimate victory for communism, however, appears greater than ever. The danger will continue as long as the Indonesian political elites, especially the officer corps, become increasingly accustomed to the presence of Partai Komunis Indonesia (PKI) members in the government. The image of the PKI is tending to sway the Indonesian political elites into believing that the Communist Party alone is able to give the country strong and purposeful government and to obtain from outside the kind and amount of aid necessary for the nation's stabilization and development. The Soviet doctrine of independent national democracy makes it possible for the PKI and the Soviet Union to justify their support for the present regime and to continue their current tactics. This should lead, eventually, to the establishment of a Communist regime not by *coup d'état* but by acclamation. 19 pp. Published in *Asian Survey*, May 1961.

P-2255. How arms controls would affect the national security budget. D. M. Iklé. 3-21-61. Unclassified.

An attempt to estimate the impact of arms controls on the future budget by considering (1) the savings resulting from the specific restrictions imposed by the agreement, (2) the cost of the inspection and control system, (3) the change in military requirements resulting from the agreement, and (4) the institutional factors which influence the level of the budget. All types of arms control agreements are likely to increase military budgetary requirements in the first year, including general and complete disarmament. In the longer run, arms controls may reduce the national security budget substantially if agreements are aimed at curtailing the ability to wage war. However, if the agreements are designed only to reduce the likelihood or destructiveness of war, expenditures may even increase in the long run. 14 pp. Illus. Published in *Air Force and Space Digest*, October 1961.

P-2257. GPS: a program that simulates human thought. A. Newell and H. A. Simon. 4-10-61. Unclassified.

A theory to explain how reasonably intelligent humans can solve some simple formal problems. The research from which the theory emerged is intimately related to the field of information processing and the construction of intelligent automata, and the theory is expressed in the form of a computer program. The rapid technical advances in the art of programming digital computers to do sophisticated tasks have made such a theory feasible. See also P-1584, P-1742, and P-2349. 26 pp. Illus. Presented before the Conference on Learning Automata at Karlsruhe, Germany, April 11-14, 1961, and published in the proceedings of the Conference.

P-2258. Why we cannot build "thinking machines" (at least at present). Nehemiah Jordan. 4-14-61. Unclassified.

A presentation of the argument that those who believe that they are going to build, or are building, a thinking machine are not really talking about thinking. In the author's opinion, we have lost sight not only of what thinking is but also of what the machine is as well. This paper (1) specifies the necessary and sufficient conditions for the construction of a machine which can be accepted as a thinking machine, (2) finds that the construction of such a machine is presently inconceivable, and (3) discusses what the currently so-called thinking machines really are. 27 pp.

P-2259. On the ultimate tensile strength and elongation of ductile materials. F. R. Shanley. 3-24-61. Unclassified.

An investigation of the relationship between ultimate tensile strength and uniform elongation. It is shown that attainment of the maximum load does not necessarily coincide with the beginning of tensile instability (necking). A theory of tensile instability is proposed, based on a linear

relationship between average true stress and true strain. The development of the neck is analyzed from the phenomenological viewpoint. Methods of achieving higher ultimate tensile strength without reduction of uniform elongation are discussed. 36 pp. Illus. Presented before the joint meeting of the Institute of the Aerospace Sciences and the American Rocket Society at Los Angeles, California, June 22, 1961.

P-2260. How useful are "scientific" tools of management? E. F. R. Hearle. 3-24-61. Unclassified.

A description of the usefulness of such scientific tools of management as linear and dynamic programming, queuing theory, game theory, simulation, and Monte Carlo. These tools are defined in terms of a model or a symbolic representation of the problem to be studied, and the steps in constructing a model are given. It is urged that public administrators become familiar with formulating problems in the explicit symbolism of the model and with the mathematical properties of these tools so that real world problems suitable for solution by their use can be recognized. 7 pp. Published in the *Public Administration Review*, Autumn 1961. Presented before the National Conference of the American Society for Public Administration at Philadelphia, Pennsylvania, April 7, 1961.

P-2261. Soviet space experiments and astronautics. F. J. Krieger. 3-31-61. Unclassified.

A chronicle of Soviet astronautics showing how doggedly and systematically the Soviet Union has approached the threshold of manned interplanetary flight. In addition to their impressive demonstration of propulsion, guidance, and scientific insight, the Soviets have demonstrated an apparent superiority in complex automatic control systems. The Soviets are transforming this superior flexibility and capability in rocket vehicle technology into a correspondingly greater lead in the exploration of outer space and its many implications. 44 pp. Illus. Published in *Aerospace Engineering*, July 1961. Presented before the Symposium on Russian Progress in Aerospace Sciences at Los Angeles, California, April 4, 1961.

P-2262. Statistical determination of error in parachute-derived wind velocities. R. R. Rapp. 3-27-61. Unclassified.

The title of this paper adequately describes its contents. 5 pp. Table. Incorporated in an article entitled, "The Meteorological Rocket Network: An Analysis of the First Year in Operation," published in the *Journal of Geophysical Research*, September 1961.

P-2263. A case for survival deep underground. H. L. Brode and J. J. O'Sullivan. 3-27-61. Unclassified.

A suggestion that the deep underground concept be applied to vital targets whose survival from even a direct hit is of utmost importance. The authors indicate in general terms the basis for such a position. These targets, important to a determined enemy, can be made less attractive to him only by making them relatively safe from a frontal attack, by making them superhard, and by sinking them below a feasible cratering depth. 8 pp. Illus. Published in *Air Force Civil Engineer*, November 1961.

P-2264-1. Some suggested techniques for data system development. J. D. Little and W. V. Shelton. December 1961. Unclassified.

A proposal of a set of techniques for use in the planning and management of data system development. These techniques are (1) critical path scheduling, specifically PEP/PERT, (2) data element identification and utilization matrices, and (3) programmed internal reporting functions. The data system may be like IOC-II, the Advanced Logistics System, or a command and control data processing system, or large-scale simulated systems of the type executed at RAND. These techniques could be useful not only in the early planning and implementation phases of system development, but also in later stages when analysis of current and earlier models of the system is occurring. 15 pp. Illus. Presented before the Association for Computing Machinery at Los Angeles, California, November 21, 1961.

P-2265. Armies in the process of political modernization. L. W. Pye. 3-28-61. Unclassified.

A chapter incorporated in the RAND-sponsored book, *The Role of the Military in Underdeveloped Countries*, ed. by J. J. Johnson, published by Princeton University Press, Princeton, New Jersey,

1962. \$7.50. Only a few years ago it was generally assumed that the future of the newly emergent states would be determined largely by the activities of their Westernized intellectuals, their socially inclined bureaucrats, their nationalist ruling parties, and possibly their menacing communist parties. It occurred to few students of the underdeveloped regions that the military might become the critical group in shaping the course of nation-building. Now that the military has become the key decisionmaking element in at least eight of the Afro-Asian countries, the situation faced is awkward in that there has been almost no scholarly research on the role of the military in the political development of the new states. 34 pp.

P-2266. Free molecule flows. Richard Schamberg. 3-23-61. Unclassified.

An analysis of the pressures and shear stresses on, and convective heat transfer to, bodies in free molecule flow. Emphasis is placed on the high-speed (hyperthermal) case relevant to satellites orbiting in the upper atmosphere. Several analytical models are formulated to represent the governing surface particle interactions. Illustrative applications of these techniques include the drag of tumbling or attitude-stabilized satellites having convex or concave surface elements. Some significant effects due to thermal motion are treated, together with two techniques for extending the analysis to lower speed ratios. 12 pp. Illus. Presented before the Statewide Lecture Series: Hypervelocity Flight in the Upper Atmosphere at the University of California at Los Angeles, April 17-19, 1961.

P-2267. The role of operational analyses in planning an effective missile ground system. S. I. Firstman. 2-1-61. Unclassified.

A discussion of the role of operational analyses and the resulting operational design criteria in the planning of readiness testing and prelaunch checkout operations and equipment. 20 pp. Illus. Published in *Aerospace Engineering*, March 1962. Presented before a joint meeting of the Institute of the Aerospace Sciences and the American Rocket Society, at Los Angeles, California, June 13-15, 1961.

P-2268. On a new computational solution of time-dependent transport processes—I: one-dimensional case. R. E. Bellman, R. E. Kalaba, and M. C. Prestrud. 3-30-61. Unclassified.

A discussion of the transformation of linear functional equations subject to boundary conditions into nonlinear functional equations subject only to initial conditions in space and time coordinates. The approach of invariant imbedding yields the reflected and transmitted fluxes as functions of basic physical dimensions. The computational treatment of the reflection of plane parallel flux from an infinite plane medium of finite thickness has already been determined for the steady state case. As a first step toward the computational solution of the corresponding problem for the time-dependent case, this paper studies the reflected flux from a one-dimensional rod for the case of neutron transport. To obtain a numerical solution, the problem of inverting the Laplace transform numerically is investigated. The method used is quite simple and is applicable to more general problems. 8 pp. Illus. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, July 1961.

P-2269. Criteria for the design and use of automated missile ground equipment to improve missile readiness. J. R. Brom. 4-20-61. Unclassified.

The title of this paper adequately describes its contents. 27 pp. Illus. Presented before the joint meeting of the Operations Research Society of America and The Institute of Management Sciences at Seattle, Washington, April 21, 1961.

P-2270. Boundary effects on the energy loss of charged particles. E. A. Stern. 4-4-61. Unclassified.

The calculation of the energy loss of a charged particle moving at a constant velocity and passing normally through the boundary between two dielectric media. Attention is focused on the effects of the boundary, and it is shown that the boundary creates two new mechanisms for losing energy. These are transition radiation and surface plasma oscillations. In addition, there are boundary corrections to the losses that are suffered by the particle in passing through the bulk material which are only important if the path length in the medium is of the order of the wavelength associated with the energy loss. The initiation of the emission of Cerenkov radiation as the particle first enters a medium is also studied. 57 pp. Illus.

P-2271. A new approach to the quantum electrodynamics of a medium. H. T. Yura. 3-31-61. Unclassified.

A method of calculating quantum electrodynamical properties of a medium composed of many atomic systems interacting with the electromagnetic field. A set of rules is obtained to allow the calculation of amplitudes corresponding to the physical processes occurring in matter. The method may be used to write a perturbation expansion in terms of Feynman diagrams. 23 pp. Illus. Presented before seminars on theoretical physics at the California Institute of Technology, Pasadena, California, May 11, 1961, and at the Bell Telephone Laboratories, Inc., at Murray Hill, New Jersey, July 5, 1961.

P-2272. Multiplicities and minimal widths for $(0, 1)$ -matrices. D. R. Fulkerson and H. J. Ryser. 4-6-61. Unclassified.

A continuation of the study of minimal α -widths for the class \mathcal{A} of all $(0, 1)$ -matrices having specified row and column sums (see P-1792). The principal contribution is a simple construction which produces a single matrix \tilde{A} in \mathcal{A} that has the following properties: (1) the partial row sum vectors of \tilde{A} are as smooth as possible in the sense of majorization, and (2) all minimal α -widths and multiplicities for \mathcal{A} can be obtained directly from \tilde{A} . The matrix \tilde{A} is also used in the solution of another class problem closely related to the minimal width problem. 21 pp. Presented before the Mathematics Department of the Southern Illinois University at Carbondale, Illinois, October 12, 1961.

P-2273. The application of human relations research to administration. Nehemiah Jordan. 4-10-61. Unclassified.

A discussion of the application of the results of academic research on human relations to real life problems in organizations. This paper attempts (1) to indicate some of the reasons which make the simple application of academic research difficult; (2) to show that this research, even as it is, can help administrators; and (3) to suggest a way of facilitating communication between administrators and academic investigators to their mutual benefit. 19 pp. Published in *Management Technology*, Fall 1961.

P-2274-1. Economic development and postwar recuperation: a comparison of industrial priorities. B. F. Massell and C. Wolf, Jr. April 1962. Unclassified.

A comparison of the priority of various industries for economic development in less-developed areas, and for economic recuperation in advanced countries in the event of thermonuclear war. Theoretical reasons for expecting both similarities and differences between industrial priorities in the development and recuperation context are discussed, as well as a particular measure of industrial priority for economic recuperation. This measure is then correlated successively with each of three different measures of industrial priority for economic development: a measure due to Hirschman based on "linkage effects," a measure due to Chenery based on the growth elasticity of different industries in connection with changes in per capita national income, and a measure of priority based on industrial growth under India's Five Year Plan. The three correlations yield different results, but suggest a weak but positive relationship between priorities in the two contexts. Some possible implications of these results for U.S. policy are then considered. 24 pp. Tables. Presented at the Brookings Institution Dedication Ceremonies at Washington, D.C., November 17, 1960.

P-2276. Computer simulation of human thinking. A. Newell and H. A. Simon. 4-20-61. Unclassified.

An illustration of the use of computer programs as theories of human thinking and problem solving by comparing a sample of human problem-solving behavior with the trace of a computer program, the General Problem Solver, instructed to solve the same problem as the human subject. This use of computers for nonnumerical simulation of symbol-manipulating processes offers a solution to the dilemma that psychology has faced (namely, that the problems of fundamental importance to the field have not always been those that existing research techniques were equipped to handle). Computer simulation promises to provide a powerful tool for constructing and testing theories of complex cognitive behavior. 25 pp. Illus. Published in *Science*, December 22, 1961.

P-2277. Simple games: an outline of the descriptive theory. L. S. Shapley. 4-11-61. Unclassified.

A presentation of the elementary properties of "simple" games. These are multiperson games in which each coalition of players is either completely ineffective or able to win outright. A tabulation of all simple games with four or fewer players is included. 29 pp. Illus. See earlier version RM-1384. Published in *Behavioral Science*, January 1962. Presented at the Mental Health Research Institute, University of Michigan, Ann Arbor, Michigan, April 20, 1961.

P-2278-1. On a moment theorem for complex Gaussian processes. I. S. Reed. 6-6-61. Unclassified.

A discussion of the characteristic function of a complex video process, sampled at N -points in time. Using the characteristic function, a general moment theorem is developed for the process. 6 pp. Published in the *IRE Transactions on Information Theory*, April 1962.

P-2279. A logician's view of language data processing. M. E. Maron. 8-30-61. Unclassified.

A description of the nature of logic and of its relation to both natural language and the problem of language data processing. An analysis is also presented of one specific language data processing problem area, namely, the problem of information identification and retrieval. 47 pp. Presented as one of a series of lectures, entitled Natural Language and the Computer, at the University of California at Los Angeles, October 21, 1960.

P-2280. Frictional effects and the meridional circulation of the mesosphere. Bernhard Haurwitz. 4-14-61. Unclassified.

The calculation of frictionally derived meridional components of wind in the mesosphere. The author shows that curvature of the vertical profile of the mean zonal wind component introduces an equatorward drift in the upper mesosphere that may account for the conjectured descent of ionospheric air over the pole in winter. 32 pp. Illus. Published in the *Journal of Geophysical Research*, August 1961.

P-2282. Reorientation of engineers to meet the challenge of a changing technology: industrial aspects of the problem. A. E. Raymond. 4-27-61. Unclassified.

A discussion of the advance planning function in terms of industry needs. Each company realizes that its competition, its projects, and its markets are subject to change and that its future health and relative position are going to be adversely affected if this change comes without notice. The elements of forward planning are outlined, and two specific improvements are suggested. The paper also examines the kinds of actions industry is taking and can take to help engineers gain new information of skills. 11 pp. Presented before the Conference on the Effective Utilization of Engineers and Scientists at Los Angeles, California, April 27, 1961.

P-2283. The Khrushchev succession problem. Myron Rush. 4-25-61. Unclassified.

An assessment of the question of Soviet succession in Khrushchev's 68th year, the fourth year of his rule. The study indicates that a succession crisis is inevitable when Khrushchev ceases to exercise dictatorial powers. The depth of the crisis, however, will depend on certain circumstances at the time. Only if the Soviet regime is seriously weakened by such a crisis is it likely that Soviet foreign policy will be redirected from its primary aim of subverting the West and achieving a communist world order. Moreover, while economic and social progress poses a serious problem for the regime and is certain to have important political consequences, it cannot, in the author's view, change the regime's totalitarian character in the years ahead unless it is seriously weakened by a succession crisis. 54 pp. Also published as RM-2763. Published in *World Politics*, January 1962. Presented before the Far Western Slavic Conference at San Francisco, California, April 30, 1961.

P-2284. Dynamic programming and "difficult crossing" puzzles. R. E. Bellman. 4-20-61. Unclassified.

An application of dynamic programming theory to a familiar type of puzzle, classified in books on mathematical reactions as "difficult crossings." A typical problem is as follows: "A group consisting of three cannibals and three missionaries seeks to cross a river. A boat is available which will hold two people, and which can be navigated by any combination of cannibals and missionaries

involving one or two people. If the missionaries on either side of the river, or in the boat, are outnumbered at any time by cannibals, the cannibals will indulge in their anthropophagic tendencies and do away with the missionaries. What schedule of crossings can be devised to permit the entire group of cannibals and missionaries to cross the river safely?" 7 pp. Published in *Mathematics Magazine*, January-February 1962.

P-2285. A method for determining approximate initial conditions for interplanetary trajectories. L. N. Rowell. 4-24-61. Unclassified.

A method for determining approximate propulsion cutoff conditions for any ballistic-type interplanetary trajectory. The trajectory is assumed to consist of two parts. The first part is an Earth-centered hyperbolic orbit which starts near the Earth, at propulsion cutoff, and extends to about one million miles from the Earth. The second part of the trajectory is an elliptical orbit about the Sun. It starts at the end of the geocentric orbit and extends to the vicinity of the destination planet. The method is based on the repeated solution of the two-body problem and a simple "orbit-patching" technique which requires a matching of velocity vectors. The method permits a computation of the approximate burnout conditions without the use of a large-scale digital computer. 28 pp. Illus.

P-2286. Economic growth and Soviet-American rivalry. A. S. Becker. 4-21-61. Unclassified.

An attempt to determine whether the USSR can catch up with and exceed the United States in the level of total or per capita output. The author discusses this rival economic power between the United States and the USSR by considering (1) the uses of economic power in the arenas of cold war conflict as means to desired ends and (2) the nexus between economic growth and the survival of the cold war power centers as active disputants in global competition. 18 pp. Presented before the Far Western Slavic Conference at San Francisco, California, April 29, 1961.

P-2287. Economic growth and foreign aid: a proposal concerning the export of industrial plants. F. T. Moore. 4-20-61. Unclassified.

A description of a program that can contribute directly to the growth of the U.S. economy and can also supply needed productive capacity to underdeveloped countries in Asia, Africa, and Latin America. In essence, the program is (1) to make available for export complete U.S. industrial plants that are obsolescing or submarginal in terms of U.S. costs and (2) to provide a means for U.S. industry to replace those plants by investment, at every attractive terms, in more modern equipment. 20 pp.

P-2288. On aspects of Korea's five-year development plan. Charles Wolf, Jr. 4-24-61. Unclassified.

A paper written during the author's stay in Korea as economic adviser to the Ministry of Reconstruction from March 3 to April 3, 1961. Part I comments on particular aspects of the economic situation, which are relevant to development planning in Korea. Part II deals with multi-sector versus key-sector growth. Part III makes suggestions for revising the Economic Development Council's statement on "Methods and Principles." Part IV discusses the author's reactions to the proposed reorganization of economic planning in Korea. 54 pp. Presented before the Ministry of Economic Development, Republic of Korea at Seoul, Korea, March 28, 1961.

P-2289. Utilization of social research in shaping policy decisions. Paul Kecskemeti. 4-24-61. Unclassified.

A discussion of the extent to which scientific advice is being used by the government. The paper describes the role of economics, sociology, social psychology, anthropology, and political science in shaping and informing governmental policy. In addition, it distinguishes three ways (namely, the discipline approach, the project approach, and an indirect and informal approach) in which scientific theory and research can be used for formulating governmental policy. 16 pp. Presented before the American Association for Public Opinion Research at the University of California at Berkeley, May 6, 1961.

P-2290. Punishment as conflict resolution. Paul Kecskemeti. 4-25-61. Unclassified.

A discourse on the attitudes toward the death penalty. The thesis presented is that our culture has no meaningful concept of punishment. The proper function of punishment (i.e., the resolution of certain conflicts) has largely been lost from view. This is why some people shirk from it while others practice it in a wholly implacable manner. Educational punishment is sometimes practiced

in families in a meaningful, conflict-resolving way. However, most punishments—severe sanctions, in particular—are handled in such a manner as to preclude meaningful conflict resolution. 35 pp. Published in *Archives of Criminal Psychodynamics*, Fall 1961.

P-2291-1. Defense and development in less-developed countries. Charles Wolf, Jr. September 1961. Unclassified.

A study of some of the economic and, to a lesser extent, the political side-effects of U.S. military assistance to the defense establishments of underdeveloped countries. The research described attempts to develop a methodology, and, in applying it, to determine how military assistance, and the structure of defense forces and budgets in the underdeveloped countries, can be modified so as to yield about equivalent military effectiveness, and yet generate substantially improved economic and political side-effects. The relevance of this research to the revolution in world politics is also discussed. 13 pp. Tables. Presented before the Conference on the Revolution of Our Time at Princeton, New Jersey, May 31–June 2, 1961.

P-2293. Magnetically driven shock waves. J. D. Cole and C. Greifinger. 5-1-61. Unclassified.

An examination of several devices in which shocks are driven electromagnetically by a source of electrical energy coupled to an ionized gas. Some approximate theories are presented for these devices, and a preliminary comparison is made with experiment. 29 pp. Illus. Presented before the Symposium on Electromagnetics and Fluid Dynamics of Gaseous Plasma at New York, New York, April 5, 1961.

P-2294-2. A new upper bound for error correcting codes. S. M. Johnson. 10-27-61. Unclassified.

A new upper bound for nonsystematic binary error-correcting codes, obtained by refining Hamming's geometric sphere-packing model. Only combinatorial arguments are used. Whereas Hamming's upper bound estimate for e -error-correcting codes involves a count of all points $\leq e$ Hamming distance from the set of code points, this paper extends the model to include consideration of points which are $> e$ distance away from the code set. The percentage improvement from Hamming's bounds is sometimes quite sizable for cases of two or more errors to be corrected. The new bound improves on Wax's bounds in all but four cases listed. 22 pp. Table. Published in *IRE Transactions on Information Theory*, April 1962.

P-2295. An introduction to automated production control system. L. S. Hill. 5-17-61. Unclassified.

A synthesized procedure for control of production using punched-card methods. The system may be considered a framework for application to any manufacturing enterprise engaged in the fabrication and assembly of parts, regardless of product. Machines are used to record and coordinate all paper-work involved in manufacturing from time of raw material receipt through transformation into finished product. The mechanization of the production control system is indicated as a logical role for the industrial engineer. 10 pp. Illus. Presented before the Twelfth Annual National Convention of the American Institute of Industrial Engineers at Detroit, Michigan, May 11–13, 1961, and published in the proceedings of the Convention.

P-2296. Simulation and tax analysis: a research proposal. W. A. Steger. 5-2-61. Unclassified.

A description of a proposed simulation model for studying certain important aspects of tax policy. An attempt is made to acquaint public finance experts with the potential rewards which new management-science and econometric tools can yield in the analysis of alternative tax proposals. The model described appears not only feasible and relatively inexpensive, but also a systematic and rational approach to a problem area which has been fraught with incertitude and controversy. 31 pp. Illus. Published in the *National Tax Journal*, September 1961.

P-2297. Linear differential systems with periodic coefficients involving a large parameter. D. C. McGarvey. 5-4-61. Unclassified.

Verification of the conjecture that the similarity in the form of the solution of ordinary differential equations with periodic coefficients, and of certain asymptotic solutions of differential equations involving a large parameter, suggests that these asymptotic results might be modified for the case of periodic coefficients to yield asymptotic estimates for the characteristic values. 46 pp. Illus.

P-2298. The rendezvous value of a metric space. O. A. Gross. 5-1-61. Unclassified.
A proof of some theorems about average distances of finite collections of points in a compact-connected metric space by means of game theory. 7 pp.

P-2299-1. Hierarchic algebra. M. C. Prestrud. November 1961. Unclassified.

A discussion of hierarchic algebra in the study of the extended family of operations whose familiar members are addition, multiplication, and exponentiation. Traditionally, algebraic operations have connected numbers. But to clarify the relationships of this family, the author assigns to each individual number a process defined as its hierarchic index. Operations with integral indices are seen to be the discrete elements of a continuous range whose operations have nonintegral indices. 22 pp. Illus. Presented before the American Mathematical Society at Cambridge, Massachusetts, October 28, 1961.

P-2300. Mathematical experimentation and biological research. R. E. Bellman. 5-8-61. Unclassified.

An attempt to describe what the functions of the mathematician should be in biomedical research. The use of mathematics in any field clarifies problem formulation and enhances the reputation of the field. Much has been gained from the application of mathematical techniques to scientific fields in the past, and the introduction of the digital computer greatly increases the promise of the future. The functions of the mathematician interested in the areas of biology and medicine are (1) to show that there are significant and intriguing mathematical questions in these new fields, and (2) to show, by example, what he can contribute to the problems of the biologist and medical researcher. 15 pp. Published in *Federation Proceedings*, January-February 1962.

P-2301-1. Approximations of Kth order to coherent detection. I. S. Reed and P. Swerling. 6-5-61. Unclassified.

A description of a class of procedures for detection of a pulsed signal having unknown frequency shift. From this class, procedures can be selected whose detection performance approximates that of coherent detection arbitrarily closely. Such procedures do not require the construction of a filter bank. On the other hand, they do not yield information as to the magnitude of the frequency shift of a detected signal. Envelope detection followed by video integration, and Reed's so-called semi-coherent procedure, are elements of this class of detection procedures. An iterative method for obtaining successively better approximations to coherent detection is described, the implementation of which would require a large number of mixing and delay operations. The number of iterations required to ensure any given degree of approximation to coherent detection, for any number of integrated pulses, is estimated. Finally, the possible application of these ideas to reception of signals by array antennas is described. 14 pp. Published in *IRE Transactions on Information Theory*, April 1962.

P-2302. Maintenance scheduling decisions and the importance of information. W. W. Haythorn. 5-9-61. Unclassified.

A description of two human factors considerations in the RAND Logistics Systems Laboratory simulation of a ballistic missile tactical organization of the mid-1960's, and of the impact of these factors on over-all system cost and effectiveness. These factors are (1) the role of maintenance management in maintaining missile alert, and (2) the requirements for maintenance personnel in accomplishing the scheduled and unscheduled maintenance necessary to assure a high degree of alert. The net effect is shown to result in an increase in missile alert time by about 15 to 20 per cent and in a drastic reduction in over-all system costs. 25 pp. Presented before the Second National Symposium on Human Factors at Arlington, Virginia, May 4 and 5, 1961.

P-2303. From chemotherapy to computers to trajectories. R. E. Bellman. 5-10-61. Unclassified.

An examination of the development of a method of handling two-point boundary problems occurring in trajectory analysis from its inception in connection with the computational treatment of a mathematical model of chemotherapy. By adopting this over-all viewpoint, maximum use can be made of the abstract qualities of mathematics, and by insisting on a complete and unified solution, new and important special properties are uncovered. 14 pp. Presented before the American Mathematical Society Symposium on Mathematical Problems in the Biological Sciences at New York, New York, April 7, 1961, and published in the proceedings of the Symposium.

P-2304. Nuclear gyros. W. H. Culver. 5-11-61. Unclassified.

Some ideas for using the direction of orientation of aligned nuclei as a direction reference. The author discusses and illustrates four devices by which the inertial properties of subatomic particles can be substituted in principle for the inertial properties of gross objects in inertial navigation systems. 14 pp. Illus. Presented before the Guidance and Control Conference of the American Rocket Society at Stanford, California, August 9, 1961.

P-2305. Limiting distributions for critical multitype branching processes. T. W. Mullikin. 5-12-61. Unclassified.

A discussion of a multitype branching process for discrete time which is a birth and death process determined by the random variables describing the first generation. The process is critical if the expectation matrix for one generation has its maximum real eigenvalue equal to 1. With probability 1, such a process dies after a finite number of generations. This paper investigates the population size of the n th generation of such a process given that the n th generation is not empty. The results of previous investigations are extended by showing that a certain conditional random variable has a limiting distribution of exponential type. This follows from results about the iterates of a k -dimensional analytic mapping near a fixed point. 20 pp.

P-2306. Variational methods in problems of control and programming. L. D. Berkovitz. 5-12-61. Unclassified.

A paper which shows how a fairly general control problem, or programming problem, with constraints can be reduced to a special type of classical Bolza problem in the calculus of variations. Necessary conditions from the Bolza problem are translated into necessary conditions for optimal control. It is seen from these conditions that Pontryagin's maximum principle is a translation of the usual Weierstrass condition, and is applicable to a wider class of problems than that considered by Pontryagin. The differentiability and continuity properties of the value of the control are established under reasonable hypotheses on the synthesis, and it is shown that the value satisfies the Hamilton-Jacobi equation. As a consequence, a rigorous proof of a functional equation of Bellman is obtained that is valid for a much wider class of problems than heretofore considered. A sufficiency theorem for the synthesis of control is also given. 45 pp. Published in the *Journal of Mathematical Analysis and Applications*, August 1961.

P-2307. Simulation of a biological system on an analog computer. E. C. DeLand. 5-23-61. Unclassified.

A mathematical model of a biological system, the first in a series of simulations which will become successively more complex and, hence, more realistic representations of the biological system. The paper demonstrates a method for simulating complex chemical equilibria and uses the respiratory function of the blood at the lung surface as an example. The analog computer is used because its characteristic parallel computation and its fast solution-time enable the simulation of dynamic systems in real time. The results obtained for a small model indicate that the accuracy and stability are sufficient for analysis within the laboratory experimental error. The method is flexible, and basic models may be expanded to incorporate more complex phenomena. 34 pp. Illus. Presented before the Third International Analog Computer Conference at Belgrade, Yugoslavia, September 4-9, 1961, and published in the proceedings of the Conference.

P-2308. Dynamic programming and linear prediction theory. R. E. Bellman. 5-16-61. Unclassified.

An extension of earlier results given in P-1147, *Dynamic Programming and Mean Square Deviation*, which applies dynamic programming theory to a particular discrete form of the linear prediction problem. 9 pp.

P-2309. Renormalization techniques and mean square averaging—I: deterministic equations. R. E. Bellman and J. M. Richardson. 5-16-61. Unclassified.

A technique for obtaining analytic approximations to the solution of nonlinear vector equations of a particular form. The paper shows the application of the method to the determination of the periodic solutions of the Van der Pol equation and the equation of the nonlinear spring. 7 pp. See also P-2335. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, August 1961.

P-2310. The allocation of functions between man and machines in automated systems.

Nehemiah Jordan. 5-16-61. Unclassified.

A discussion of the complementary relationship between men and machines in an attempt to allocate functions between them in automated systems. What makes a job a challenge to man must be clarified, and those challenges must be built in every task assigned to the human operator. Otherwise man will not complement the machine, but will begin to function like a machine. When man is forced to do this, he realizes that he is being used inefficiently. Nothing could be more self-defeating in the long run than the construction of man-machine systems which cause the human components in the system to rebel against the system. 11 pp. Presented before The American Society of Mechanical Engineers at Los Angeles, California, June 11-14, 1961.

P-2311. Forgetting in an association memory. E. A. Feigenbaum and H. A. Simon. 5-24-61. Unclassified.

A discussion of two experiments with human verbal learning, and an explanation of the interference phenomena in terms of the EPAM (Elementary Perceiver and Memorizer) model. A model of an association memory, the EPAM, is a learning system, a computer simulation of human verbal learning processes. No stored information in this memory is ever physically destroyed. Yet the behavior which is normally called "forgetting" occurs because of a loss of access (temporary or permanent) to information stored in a growing net of associations. In this system, forgetting occurs as a direct consequence of normal learning processes (i.e., forgetting is the result of the interference of items later learned with items learned earlier) without the postulation of a separate mechanism. 9 pp. Presented before The Association for Computing Machinery at Los Angeles, California, September 5-8, 1961, and published in the proceedings of the Meeting.

P-2312. Computer simulation of human thinking and problem solving. A. Newell and H. A. Simon. 5-29-61. Unclassified.

A discussion of the use of computers to simulate human thinking, with emphasis on the organization of symbolic processes to perform complex thinking tasks. The authors speculate about the form that fundamental theory in this field is taking, rather than about the implications of that fundamental theory for everyday affairs. Such aspects are considered as the proofs already afforded by computer programs, a description of the General Problem Solver, speech acquisition, and the state-process dichotomy. 30 pp. Published in two parts in the June and July 1961 issues of *Datamation*. Based on a talk given on March 23, 1961, by H. A. Simon at the Massachusetts Institute of Technology Centennial Lecture Series on "Management and the Computer of the Future."

P-2313. The Indonesian eight-year over-all development plan. G. J. Pauker. 5-15-61. Unclassified.

A discussion of the development plan which now represents the officially sanctioned policy of the Indonesian government. The A projects outlined, which are primarily concerned with the improvement of the living conditions of the Indonesian population, are not excessively ambitious and will have to be carried out in some way, else the situation in Indonesia will deteriorate drastically in the years ahead. The plan's B projects imply that the financing of development is not secured. Those areas most important among the A projects are research, rice production, fertilizers, textiles, antibiotics, land and air transport, shipping, and telecommunications. 38 pp. Also published as RM-2768. Published in *Pacific Affairs*, Summer 1961.

Ø P-2314. Aspects of synchronous communication satellites. N. E. Feldman. 5-18-61. Unclassified.

An analysis of the problems involved in making a space communication system operational. The system examined is the geocentric stabilized, station-keeping, active satellite system in a synchronous orbit. The problems of operating such a system include satellite design and equipment, repeater design, booster capacity, economic feasibility, and frequency requirements. 66 pp. Illus. Published in the *ARS Journal*, April 1962. Presented before the joint meeting of the Institute of the Aeronautical Sciences and the American Rocket Society at Los Angeles, California, June 13-16, 1961.

P-2315. Dependency systems and phrase structure systems. Haim Gaifman. 5-22-61. Unclassified.

A comparison between dependency and phrase-structure systems. First, a dependency system is defined, together with the dependency tree that corresponds to a sentence. Secondly, a phrase-structure

system and the phrase-structure that corresponds to a sentence are defined. It is shown that the dependency system is more or less equivalent to a special class of phrase-structure systems. Precise definition and properties of that class are given. 68 pp. Illus.

P-2316. Some economics of property. A. A. Alchian. 5-26-61. Unclassified.

An attempt to separate and classify various types of "rights" constituting ownership, renting, leasing, and trusteeship. The purpose is to contrast the implied behavior consequences under various groupings of rights. In particular, the paper is directed toward aiding analysis of the various methods of assigning and using radio frequencies. Effects of rights to transfer and bearing of responsibility are discussed. 77 pp. Illus.

P-2317. A malfunction-generation model for a manned simulation of ICBM logistics.

E. E. Bean. 5-24-61. Unclassified.

A description of a malfunction-generation model developed for a manned simulation of an ICBM operational tactical unit from 1963 to 1965. The model's inputs consist of three kinds of information: reliability, supply, and maintenance. All three are needed for each of the "support units," or parts of a weapon system capable of being supported at the base-level echelon of support. Although the model uses supply and maintenance information, this paper is primarily concerned with deriving the reliability inputs for each of the logistic elements. The model's outputs are a realistic maintenance workload and the logistic requirements this workload demands. 27 pp. Illus. Presented before the Third Annual Joint Western Regional Meeting, sponsored by the Operations Research Society of America and The Institute of Management Sciences, at Seattle, Washington, April 20, 1961.

P-2318. Analytic methods and approximations of MHD problems. J. D. Cole and C. Greifinger. 5-16-61. Unclassified.

A discussion of the various approximations involved in the analysis of certain magnetohydrodynamic devices (namely, inverse pinch, Scylla, MAST). It is shown that estimates can readily be obtained if a simplified mechanical model of the plasma (snowplow model) is assumed and if the reaction of the plasma on the external circuit is neglected. When the reaction on the circuit is considered and a more realistic mechanical model is used, the analysis becomes more difficult but provides more detail. 35 pp. Illus. Presented before the Air Force Special Weapons Center meeting on Numerical Methods of Fluid Flow at Kirtland Air Force Base, New Mexico, May 16-18, 1961.

P-2319. Some limitations of automatic test equipment. S. I. Firstman. 5-22-61. Unclassified.

A discussion of some of the limitations of automatic test equipment (ATE), given in a panel discussion on the same subject by an IRE group at Los Angeles, California, May 22, 1961. The limitations are in four categories: (1) those of automatic testing, per se, (2) those related to ATE-prime equipment interactions, (3) those associated with ATE within its environment, and (4) those concerned primarily with man-machine relations. 8 pp.

P-2320. On a new functional transform in analysis: the maximum transform. R. E. Bellman and W. Karush. 5-25-61. Unclassified.

The title of this paper adequately describes its contents. 9 pp. Published in the *Bulletin of the American Mathematical Society*, September 1961.

P-2322. The use of manned simulation in the design of an operational control system. M. A. Geisler and W. A. Steger. 5-25-61. Unclassified.

A study of the general features of the planning and operations phases of a new weapon system. The uncertainties inevitable in planning mean that considerable effort is made during the operations phase to adjust the weapon system and its resources to the actual environment it finds so as to attain the desired level of operational capability. The adjustment mechanism is called an operational control system, and its elements are described. The proposal is made that a better control system can be designed if simulation is used to help design it during the planning phase. The use of simulation will not only produce a better control system earlier, but it will permit the planners to adjust the other resources provided for the weapon system so that they are compatible with the environment and the control system. An example of such a designed system is included, 12 pp. Illus. Presented before the Western Joint Computer Conference at Los Angeles, California, May 9-11, 1961, and published in the proceedings of that Conference.

P-2324. Dynamic programming and the variational principles of classical and statistical mechanics. R. E. Kalaba. 5-21-61. Unclassified.

A new approach to problems in the calculus of variations through the functional equation technique of dynamic programming. This paper explores some of the applications of these techniques in the analysis of dynamic processes (characterized by the principle of least action) and static processes (characterized by the principle of minimal potential energy). Since optimal processes involving stochastic elements are amenable to such treatment, the determination of most likely trajectories through phase space is also discussed. 22 pp. Illus. Presented before the Fifth Midwestern Conference on Solid Mechanics at East Lansing, Michigan, September 6-8, 1961, and published in the proceedings of the Conference.

P-2325. Tests of homogeneity for correlated samples. Albert Madansky. March 1962. Unclassified.

A presentation of techniques for testing various hypotheses related to the notion of temporal homogeneity of a population each of whose members can belong to any one of S states at any time. These hypotheses include Cochran's permutability hypothesis, the hypothesis of strict exchange, the usual homogeneity hypothesis for multinomial distributions in the presence of correlated samples, and the hypothesis that a first order Markov chain is in a steady state. 46 pp.

P-2327. Dictionary problems in machine translation. K. E. Harper. 5-29-61. Unclassified.

A discussion of the chief problems in building and operating MT (machine translation) dictionaries and of the areas in which progress has and has not been made. To emphasize a broad concept of the MT dictionary, the author states several reasons for the concentration of effort that has gone into its preparation, the chief developments in MT dictionaries in terms of the text lookup function, the desirability of performing syntactic analysis on the input sentence, and the required capability of easy and cheap modification of present and future MT dictionaries. 15 pp. Presented as a lecture in the course on computational linguistics at the University of California at Los Angeles, October 1960.

P-2328. Mathematical aspects of adaptive control. R. E. Kalaba. 5-14-61. Unclassified.

A mathematical treatment of adaptive control processes based on the use of the functional equation technique of dynamic programming. The paper discusses (1) the nature of adaptive control, (2) processes in which the results of decisions are not known precisely, (3) processes in which decisions must be made with incomplete information concerning the state of a system, (4) processes with the objective only partially known, and (5) other problems of current interest. 33 pp.

P-2329. The effect of plasticity on decoupling of underground explosions. A. L. Latter, E. A. Martinelli, W. G. McMillan, and J. Mathews. 6-1-61. Unclassified.

A study of the effect of plasticity, including work hardening, on seismic decoupling of underground explosions for large spherical cavities designed to give maximum decoupling and for small (overdriven) cavities designed to give partial decoupling. It is found that plasticity plays no role for maximum decoupling cavities, even those at great depth for which some plastic flow occurs during construction of the cavity. For overdriven cavities at great depth, plasticity affects the decoupling factor by an amount depending upon the degree of overdriving and the depth, as well as the detailed stress-strain relation of the medium. For cavities at a depth of about one kilometer in a medium like salt, which exhibits work hardening, the decoupling factor will be at least as great as that obtained in the overdriven Cowboy experiments and could be appreciably greater. It is also concluded that the depth of the Cowboy experiments was not sufficient for plastic flow to occur in the salt medium before other inelastic behavior set in. A simplified model of the Cowboy inelasticity is discussed. 26 pp. Illus. Published in the *Journal of Geophysical Research*, September 1961.

P-2330. Laos in strategic prospective. H. B. Fredman. 6-7-61. Unclassified.

A review of the strategic value of Laos since the 19th century European struggle in Southeast Asia for a balance of power. After the decline of French power in 1945, the Communist bloc and the Western alliance became the two contending powers in the area. The present focus of world interest in Laos is largely the result of the Lao failure, particularly after 1954-1955, to redevelop the Lao

internal structure. The danger of a continuity of Communist efforts to occupy the shell of Laos, via a military *fait accompli*, is becoming increasingly apparent. The Western system of alliances is in jeopardy, and the total system of balances and checks is being affected. 17 pp.

P-2331. Historical note on the 1.5 factor of safety for aircraft structures. F. R. Shanley.
6-2-61. Unclassified.

A recollection of how the 1.5 factor of safety was chosen for aircraft structures. Selected rather arbitrarily, the factor has worked with subsonic aircraft except for fatigue. There appears to be a need for an intensive study of structural airworthiness requirements, with particular emphasis on factors of safety and related matters. 5 pp.

P-2332. Motivational problems in human-computer operations. Nehemiah Jordan.
6-5-61. Unclassified.

A discourse on the profession of human factors engineering, which should concentrate on the role of motivation in designing complex man-machine systems. Past emphasis has been on making jobs easy, but now effort should be made to make jobs interesting for every human operator at every skill level. In doing this, the lot of the human operator as a man will be improved, as well as the over-all system performance. 11 pp. Published in *Human Factors*, June 1962. Presented before the Ninth Annual Human Engineering Conference at St. Louis, Missouri, June 1-2, 1961.

P-2333-1. Recent developments in nonlinear programming—part II. P. S. Wolfe.
8-30-61. Unclassified.

A sequel to P-2063, *Recent Developments in Nonlinear Programming—Part I*. The two papers constitute a survey of the basic features of the principal current proposals for the computational solution of nonlinear programming problems. Paper P-2063 discusses the gradient methods. This paper presents those procedures based essentially on the simplex method for linear programming. 33 pp. Illus. Presented at the Fifteenth National Conference of the Association for Computing Machinery at Milwaukee, Wisconsin, August 24, 1960.

P-2334. A new approach to the duality theory of mathematical programming. S. E. Dreyfus and M. Freimer. 6-26-61. Unclassified.

The embedding of a mathematical programming problem in the more general problem in which the optimal return is considered to be a function of the available input commodities and is central to the method used. A simple characterization of the properties of the optimal return function leads directly and intuitively to the duality theory of linear programming and also to the Kuhn-Tucker results for quadratic programming. Furthermore, this approach yields immediate economic interpretation of the quantities involved. It is similar to that of dynamic programming and has also been adopted to yield the classical results of the calculus of variations. 12 pp. Table.

P-2335. Self-consistent solutions of deterministic and stochastic nonlinear differential equations. R. E. Bellman and J. M. Richardson. 6-6-61. Unclassified.

A discussion of an approximation method (described in P-2309, *Renormalization Techniques and Mean Square Averaging—I: Deterministic Equations*) for solving nonlinear ordinary differential equations in which the nonlinear terms are approximated by a linear expression. The linear approximation is achieved by minimizing the mean square error where the averaging procedure is chosen in advance. This paper discusses a modification of the earlier method in which the averaging procedure itself depends on the approximate linear differential equations that are derived. Averaging procedures are considered that are stationary in connection with the derived approximate linear equations. The method is called the "self-consistent parameter" method because the parameters associated with the averaging must be made consistent with those contained in the derived equations. 13 pp.

P-2336. The role of the military comptroller in defense management. David Novick.
6-6-61. Unclassified.

A paper that discusses the military comptroller's role and identifies the comptroller in the programming process. Performance of the comptroller's role demands a clear understanding of the terms not only in which top management can effectively make national security decisions, but also in which operating management can effectively implement those decisions. The budgetary process for FY 1963 represents a significant first step toward the full-scale introduction of the program concept. However,

those responsible for designing and installing the new procedures in the Department of Defense should avoid the mistake of overloading the new system by confusing the detail desirable for analysis and choice with the freedom desirable for operating within specified limits. 9 pp. Published in *Armed Forces Comptroller*, December 1961. Presented before the American Society of Military Comptrollers at Washington, D.C., June 1, 1961.

P-2337. Human factors in systems research. W. W. Haythorn. 6-7-61. Unclassified.

A description of some systems research efforts in which human factors considerations played key roles. Some techniques for examining human factors problems in a broad systems context are discussed: (1) the allocation of tasks to men and machines, (2) the estimation of manpower requirements by skill types and levels, (3) systems training, (4) decision analysis, (5) the use of simulation in systems design, and (6) more basic human factors research. Many ways are shown in which human factors considerations improve system performance. 32 pp.

P-2338. The quantification of functional load. C. F. Hockett. 6-7-61. Unclassified.

An attempt to determine whether a valid—perhaps even a practical—way of quantifying functional loads can be formulated. Three cases are considered: (1) a load in terms of phonemic contrasts, (2) a load in terms of allophonic contrasts, and (3) a load in terms of arbitrary symbols. If a valid way of quantifying functional loads can be formulated, it would be of use not only in the context of historical linguistics, but also in some other, and unexpected, connections. 30 pp. Illus.

P-2340. Civil defense training in Russia. Leon Gouré. 6-8-61. Unclassified.

A discussion of Soviet efforts, especially since 1955, to develop a large civil defense organization and to train the majority of its population in civil defense. Such aspects are considered as organization and administration, training objectives and program, training procedures and techniques, control over participation and quality, and the present status of civil defense training. 15 pp. Incorporated in a book entitled *Civil Defense in the Soviet Union*, published by the University of California Press, Berkeley and Los Angeles, California, 1962. \$4.95. Published in *The Journal of the American Society of Training Directors*, September 1961.

P-2341. Wave branching processes and invariant imbedding—I. R. E. Bellman and R. E. Kalaba. 6-13-61. Unclassified.

An analysis of how, through a new mathematical formulation, to use invariant imbedding and the principle of wave localization to treat wave processes. It is assumed that in the wave processes there can be creation and destruction of waves, as well as transmission and reflection. From an extension of these techniques, the equation for the expected reflection coefficient can be derived. 6 pp. Illus. Published in the *Proceedings of the National Academy of Sciences of the United States of America*, September 1961.

P-2342-1. On regional development and dynamic models. F. T. Moore. November 1961. Unclassified.

A discussion of the problem of criteria for regional development. The author examines one type of growth model, based on the maximization of the output-investment ratio. This apparently persuasive way of looking at the problem of growth is shown to have some serious flaws. In addition, a reformulation of a regional growth model is presented, and some results of its application to the economy of the State of California are analyzed. 27 pp. Illus. Presented before the International Conference on Economic Development at Geneva, Switzerland, September 11–15, 1961.

P-2343-1. Equations of perturbed motion for low-eccentricity orbits. F. T. Smith. 10-31-61. Unclassified.

The derivation of a set of differential equations that defines the perturbed motion of a celestial body in terms of a particular set of orbital parameters well suited to orbits that are circular or nearly so. Applications of the equations to the calculation of general perturbation, special perturbations, and orbit transfers are suggested. 31 pp. Illus.

P-2344. Prelude to policy: understanding. M. D. Shulman. 6-9-61. Unclassified.

An article emphasizing that the United States should think in steadier and more realistic terms about the Soviet problem, and should distinguish decisive factors from those that are secondary. Even now, current discussions of U.S. foreign policy reflect some serious misconceptions about the essential nature of the conflict. These misconceptions need to be clarified if the United States is to

move on to a new and more effective stage in response to the Soviet challenge. 20 pp. Published in *The New York Times Magazine*, July 16, 1961.

P-2345. Recalculations of cloud electrification based on a general charge-separation mechanism. J. D. Sartor. 6-9-61. Unclassified.

The title of this paper adequately describes its contents. 3 pp. Illus. See earlier study P-2121. Published in the *Journal of Geophysical Research*, September 1961.

P-2346. Glossary of terms on national security. S. M. Genensky and O. Helmer. 6-12-61. Unclassified.

A glossary that attempts to define some of the more important and frequently used terms that are apt to occur in written or oral discussions of national security. 12 pp. Also published as RM-2754. Quoted in *Bulletin of the Atomic Scientists*, November 1961.

P-2347. Political doctrines and practical politics in Southeast Asia. G. J. Pauker. 6-16-61. Unclassified.

A discussion of the struggle for independence and reform in Southeast Asia in terms of imported political theories, adopted and applied without major efforts to re-examine and modify them in the light of local conditions. The result, evident after independence, was that Southeast Asian politics lacked clarity of purpose and firmness of direction. The institutions—adopted either on the basis of explicit acceptance of alien political theories or without profound meditation about their implicit philosophies—revealed discrepancies with the world views embedded in the folk cultures of the area and with habits shaped by history. Consequently, the thinking and rethinking of fundamental presuppositions, neglected in the years of preparation and struggle, had to occur under the pressure of increasing domestic difficulties and of the ideological challenge of Communism. 18 pp.

P-2348. A q -version of the Newton interpolation formula and some Eulerian identities. R. E. Bellman. 6-16-61. Unclassified.

The title of this paper adequately describes its contents. 6 pp. Published in *Bollettino della Unione Matematica Italiana*, Vol. 16, No. 3, 1961.

P-2349. Experiments with a heuristic compiler. H. A. Simon. 6-30-61. Unclassified.

A description of some experiments in constructing a compiler that makes use of heuristic problem-solving techniques such as those incorporated in the General Problem Solver. The experiments attempt to determine the problems of constructing more powerful programming languages and compilers and to test whether the task of writing a computer program can be considered a "problem" in the sense in which that term is used in the General Problem Solver. 87 pp. Illus. See also P-1584, P-1742, and P-2257.

P-2350-1. Munk integrals for fully cavitated hydrofoils. B. R. Parkin. 11-15-61. Unclassified.

The use of a linearized closed-cavity theory to obtain a solution for the two-dimensional cavity flow around a cambered hydrofoil of arbitrary shape. Integral representations for the hydrodynamic coefficients of the profile are found by superposing certain fundamental solutions. To test the theory, calculations are carried out for a "low drag" profile for which experimental data are available. Satisfactory agreement between experiment and theory is obtained. 32 pp. Illus.

P-2351. American attitudes toward war: their influence on arms control proposals. H. A. DeWeerd. 6-21-61. Unclassified.

A review of the attitudes of the American people toward war in the past and of the ways in which the United States has become involved in war. Reasons are discussed for the failure to achieve any important agreement in the nuclear disarmament field through negotiations with the Soviet Union. The author believes that American attitudes toward war and toward the use of force in international affairs have exerted an important influence on U.S. arms control proposals. 20 pp. Presented before the National Security Studies Program of the University of California at Los Angeles, May 12, 1961.

P-2352. Concepts of limited war: an historical approach. H. A. DeWeerd. November 1961. Unclassified.

An examination of the concepts of general and limited war against the background of history-making trends and developments since 1945. The paper discusses the concept of total war for the United

States from 1945 to 1950, the ten years of collective security from 1950 to 1960, and the present state of limited war and strategic balance. The author concludes that the United States must maintain not only a condition of at least approximate strategic balance with the Soviet Union in the 1960's, but also a limited war capability. This is necessary to enable the United States to contest a fairly wide range of possible communist aggressions in the third areas of the world. 20 pp.

P-2353-1. Vehicle dynamics: NSF/Stanford Rocket Propulsion Institute. R. W. Buchheim. 7-5-61. Unclassified.

The text of a lecture given in Palo Alto, California, in June before the 1961 Stanford University-National Science Foundation Summer Institute in Rocket Propulsion for College Engineering Teachers. Such topics are discussed as the principles of rocket flight, elementary space-flight operations, the motion in a central gravitational field, earth-bound trajectories, satellite trajectories, lunar flight, interplanetary flight, and orientation control. 111 pp. Illus.

P-2354. Wind and temperature in the mesosphere. R. R. Rapp. 6-28-61. Unclassified.

An exploration of what is known and surmised about the winds and temperature of the mesosphere. The author compares and contrasts both data and theory, presents tentative cross sections of the mesosphere, and pleads for augmentation of the admittedly sparse data. 17 pp. Illus.

P-2355. Game-simulation and long-range planning. R. M. Rauner and W. A. Steger. 6-22-61. Unclassified.

A description of the game-simulation work conducted in RAND's Logistics Systems Laboratory to aid long-range logistics planning in the United States Air Force. The background of these experiments is described, along with the three experiments performed to date. The game simulations are then assessed in terms of their benefits and limitations in relation to the problems of long-range planning. Speculations are also made on possible future uses of this game-simulation technique. 28 pp. Presented before The Institute of Management Sciences at Brussels, Belgium, August 23-26, 1961.

P-2357. Variational problems with inequality constraints. S. E. Dreyfus. 8-2-61. Unclassified.

Consideration of variational problems restricted by inequality constraints after deductions of the appropriate form of the multiplier rule. It is shown that no further theory is required if the constraint explicitly involves the decision variable. The study then derives the more complex conditions necessary for optimality for curves constrained to lie in a region of the state variable space. 19 pp. An extension of P-1464. See also P-2374. Published in the *Journal of Mathematical Analysis and Applications*, April 1962.

P-2358. Performance of a reading task by an elementary perceiving and memorizing program. E. A. Feigenbaum and H. A. Simon. 7-5-61. Unclassified.

An account of some experiments which show that the mechanisms postulated in the Elementary Perceiver and Memorizer (EPAM) for the rote memory tasks are adequate for simulating, at least macroscopically, the processes used by human beings in acquiring the ability to read and understand printed words. The author provides a summary description of the EPAM program, mentions the main processes it uses in rote memory tasks, and describes how these processes are used in learning to read. 14 pp. Illus.

P-2359. Overlapping tessellated communications networks. L. J. Craig and I. S. Reed. 6-13-61. Unclassified.

A philosophy of interconnecting communication networks that have the appearance of overlapping tessellations. The paper derives the bandwidth requirements for two types of networks (namely, linear spanning and inclusive spanning). The efficacy of one network as compared with the other is measured by the additional switching requirements for various spanning doctrines. 18 pp. Illus. Published in *IRE Transactions on Communications Systems*, March 1962. Presented before NORAD and ADC representatives at NORAD Headquarters, Colorado Springs, Colorado, July 5, 1961.

P-2360. The Soviet oil offensive. Harold Lubell. 6-26-61. Unclassified.

A discussion of the future prospects for increased Soviet oil exports. Several examples are then cited in examining the aims and techniques of the USSR in penetrating non-Soviet oil markets. The implications for the West of the Soviet oil export drive are also considered. 34 pp. Published in *The Quarterly Review of Economics and Business*, November 1961.

P-2361. A note on perturbation series. R. E. Bellman, R. E. Kalaba, and R. Vasudevan. 6-27-61. Unclassified.

A study which assumes that the solution of the nonlinear differential equation

$$u'' + u + \varepsilon g(u, u') = 0, \quad u(0) = c_1, \quad u'(0) = c_2,$$

is periodic for all real choices of c_1 and c_2 . The paper does not attempt to study the periodic solution itself, but rather the behavior of the period T as a function of c_1 and c_2 . 10 pp. Published in the *Journal of Mathematical Analysis and Applications*, April 1962.

P-2362. On the determination of occupational categories in an organization. D. S. Stoller. 6-27-61. Unclassified.

An attempt to determine the number of occupational categories of repair men in an organization by analyzing the implication of three types of personnel policies. The first is a completely task-oriented personnel policy, which assumes that each specialty covers one or more kinds of tasks to be performed and that these tasks do not differ very much over the different specialties. The second is a specialty-oriented personnel policy, which assumes that each subsystem of the equipment to be repaired represents a complex task which can only be performed by highly specialized personnel. The third policy recognizes that equipments to be repaired are composed of subsystems that often require different specialties, but that at the same time the occupational categories can reflect a greater versatility, which can be achieved by the cross-training of personnel. 10 pp. Presented before The Institute of Management Sciences at Brussels, Belgium, August 23-26, 1961.

P-2363. An algorithm for scaling matrices. D. R. Fulkerson and P. S. Wolfe. 6-28-61. Unclassified.

An algorithm for optimal "matrix scaling"—multiplying rows and columns of a rectangular matrix by different factors so as to optimize its condition. The method is expected to improve the computational solution of linear programming problems. 12 pp. An abridgment of RM-2956-PR.

P-2365. Wave-induced motions of a large rocket vehicle drifting in a vertical attitude. J. J. Leendertse. 6-29-61. Unclassified.

Results of a theoretical and experimental laboratory study of the movements of a large solid-propellant rocket vehicle drifting in a vertical attitude in uniform waves and in the wave environment of the open sea. Measurements are made of the movement in heave and pitch of a 1:120 scale model of a 175-ft-long vehicle. Experimentally obtained results compare well with those obtained analytically. 42 pp. Illus. Presented before the American Society of Mechanical Engineers at New York City, November 26-December 1, 1961.

P-2366. Improving the mutual guidance and support between the fields of materials and design. W. R. Micks. 7-6-61. Unclassified.

A discussion of some of the important functions that should be embodied in the interactions between the fields of materials and design. Some possible mechanisms are also suggested for improving the performance of these functions. 13 pp. Illus. Presented before the Air Force Systems Command Materials Symposium at Phoenix, Arizona, September 13-15, 1961, and published in the proceedings of the Symposium.

P-2367. Near free molecule flows: review of analysis and results. A. F. Charwat. 7-5-61. Unclassified.

A review of various analyses of near-free-molecule flows over blunt and slender shapes. Theoretical results are compared with experimental data in certain cases. 70 pp. Illus. Presented at the Spring 1961 Lecture Series on Hypervelocity Flight in the Upper Atmosphere, University Extension of the University of California, at Palo Alto, May 1, 1961, at Corona, May 2, 1961, at Los Angeles, May 3, 1961, and at San Diego, May 4, 1961.

P-2368-1. On the continuation of orthogonal structure across a surface of discontinuity in the momentum-energy tensor. D. G. B. Edelen. 8-15-61. Unclassified.

A discussion of Einstein's general relativity field equations, the study of which is usually begun by assuming certain particular forms for the metric tensor. In the presence of a general momentum-energy tensor that admits jump discontinuities, the question arises as to the consistency of the assumed metric structure in regions where the jumps in the momentum-energy tensor occur. To answer this question, the author examines the continuation of orthogonal structure across surfaces

of discontinuity in the momentum-energy tensor and analyzes the problems of several massive bodies of finite extent. It is concluded that, although orthogonal structure for problems of the second and third classes can generally be continued, the problems of the first class will only admit orthogonal structure, everywhere in the space under very particular circumstances. 11 pp. See also P-2369 and P-2411. Published in the *Journal of Mathematical Analysis and Applications*, May 1962.

P-2369. Discontinuities in the Einstein-field for general momentum-energy tensors.

D. G. B. Edelen and T. Y. Thomas. 7-6-61. Unclassified.

An analysis of the problems (associated with discontinuities in the components of the momentum-energy tensor and with discontinuities in the second derivatives of the components of the metric tensor) for spaces in which the Einstein field equations of general relativity hold. Explicit solutions are obtained for values of the discontinuities in the second derivatives of the components of the metric tensor in terms of the discontinuities in the components of the momentum-energy tensor, where this tensor is left arbitrary. The equations describing the evolution of these discontinuities are obtained and reduced, and the equations of motion are evaluated across the resulting discontinuity surfaces. 43 pp. See also P-2368-1 and P-2411. Published in *Archive for Rational Mechanics and Analysis*, March 1962.

P-2370. Analysis of the formation of Meteor Crater, Arizona: a preliminary report.

R. L. Bjork. 7-6-61. Unclassified.

A study of the cratering process accompanying the impact of a 12,000-ton iron projectile on a semi-infinite half space of soft rock at a velocity of 30 km/sec. The constituents and velocity approximate those involved in the formation of Meteor Crater, Arizona. The motion is solved numerically, and graphs showing details of the motion are presented. It is concluded that the meteorites would have a mass of between 30,000 and 194,000 tons, the range being due to the uncertainty in the impact velocity. 27 pp. Illus. Published in the *Journal of Geophysical Research*, October 1961. Presented before the Cratering Symposium at Washington, D. C., March 29, 1961.

P-2371. Minimal k -arc-connected graphs. D. R. Fulkerson and L. S. Shapley. 7-12-61.

Unclassified.

A solution to the problem of determining the fewest number of arcs required in a k -arc-connected graph on n nodes by describing constructions that produce such graphs having $kn/2$ arcs (for kn even) or $(kn+1)/2$ arcs (for kn odd). (A linear graph is k -arc-connected if it is necessary to remove at least k arcs in order to disconnect the graph.) The results of this study are applicable to the problem of synthesizing minimum cost, " k -reliable" communication networks. 13 pp. Illus.

P-2373. An extended composite algorithm for linear programming. P. S. Wolfe.

7-24-61. Unclassified.

An extension of the composite simplex algorithm for linear programming. This extension promises a reduction in the labor of solving problems not having initial feasible solutions. 15 pp.

P-2374. The numerical solution of variational problems. S. E. Dreyfus. 8-30-61.

Unclassified.

A discussion of the numerical solution of variational problems of both the conventional and inequality constrained types. The author outlines briefly what, until recently, has been the usual approach. A gradient technique is then considered that has proved very successful in practice. Finally, the numerical solution of a variant of the classical brachistochrone problem is examined where a state variable inequality constraint has been introduced, but for which the analytic solution is still known. 28 pp. Illus. See also P-1464 and P-2357.

P-2375. A theory of the serial position effect. E. A. Feigenbaum and H. A. Simon.

7-18-61. Unclassified.

A presentation of an information processing theory of rote serial learning sufficient to predict (qualitatively and quantitatively) the shape of the serial error curve. In addition, other rote-learning phenomena are explained. The theory postulates a serial information processing mechanism that learns (on the average) one item from a serial list every k seconds, has a very small immediate memory span, and uses an anchor-point processing strategy for organizing its learning effort over time. Two ways described to make predictions from the postulates are by a computer programmed to process information and by a simple mathematical model. 35 pp. Tables.

P-2376. Note on program uncertainty in dynamic inventory problem. R. C. Kao. 7-19-61. Unclassified.

A study of the dynamic inventory problem for a follow-on provisioning in which the program length is subject to uncertainty with a known distribution. It is shown that under rather general cost conditions, the optimal policy is of the (S, s) type. This is true whether or not there exists a time lag in delivery provided that excess demand is always backlogged. The case of infinite program horizon is also discussed. 12 pp. Published in *Econometrica*, April 1962.

P-2377-1. Path-invariant comma-free codes. W. B. Kendall III and I. S. Reed. September 1961. Unclassified.

A definition of a subclass of comma-free codes that has the property of path invariance. Certain path-invariant comma-free dictionaries (using K symbols to form n -symbol words) are developed, and their properties are studied. The sizes of these dictionaries are compared with those for general comma-free codes. The principal advantage of this class of comma-free codes is the ease of establishing the positions of the divisions between words. 22 pp. Illus.

P-2379. Entropy and conjugacy. T. A. Brown. 7-24-61. Unclassified.

The development of the theory of entropy as a conjugacy invariant of measure-preserving transformation. This is done in an elementary way without mentioning information theory or invoking McMillan's theorem or the martingale theorem of Doob. Ways are also examined in which the entropy invariant can be generalized to give other invariants. 17 pp.

P-2382-1. Communist China's demands on the world. A. M. Halpern. 10-9-61. Unclassified.

A general schema for determining what the Chinese Communists are trying to achieve in their relations with the non-Communist world. The discussion deals with the strategic goals and tactical methods used by the Chinese Communists to alter the international environment by revolution. Their methods tend to form patterns whose variations through time correlate with changes in the goals pursued. For any given period, the strategic goals described and the pattern of methods selected to attain these goals constitute a grand strategic design, which at any given time is also part of the official line. The propositions advanced indicate the shape of a frame of reference within which questions appropriate to such analyses can be formulated. 29 pp. Presented before the American Political Scientists Association at St. Louis, Missouri, September 6-9, 1961.

P-2383. Anyone for the moon? J. D. Williams. September 1961. Unclassified.

Arguments showing that an expedition to the Moon is a good idea from the standpoint of our mutual benefit and posterity. The benefits of prestige, economic growth, and intellectual development derived from the lunar project would more than counterbalance the problems of cost and the resulting tax burden. However, the author feels that the lunar project could fail in that it is not really ambitious enough. The need is stressed for grander goals, such as exploring the solar system, or beyond. 10 pp. Published in the *Congressional Record*, Congress of the United States, 87th Congress, 2d Session, April 2, 1962, U.S. Government Printing Office, Washington, D.C., 1962. Presented before The Princeton University Conference at Princeton, New Jersey, October 4, 1961.

P-2384. A boundedness property of the closed linear model of production. S. G. Winter, Jr. 7-28-61. Unclassified.

A proof of a boundedness property of infinite feasible sequences in closed, convex linear technologies. A well-known theorem on such technologies states that, under quite general conditions, there exists a maximal rate of balanced growth and a set of proportions of the various commodities in the technology for which this rate is achieved. In this paper the proposition is proved that the fact that unbalanced growth paths are feasible does not negate the special significance of the maximal rate of balanced growth. 9 pp.

Ø **P-2386-1. The succession problem and the transition to Communism.** Myron Rush. December 1961. Unclassified.

A discussion of the difficulty in arranging the succession to the dictator in a totalitarian dictatorship. For a regime that has pledged itself to transform the existing society into a Communist one, the succession problem is fundamental. The author considers the reasons for this in relation to their bearing on the drafting and the prospects of the current Soviet program for the achievement of

Communism. It is concluded that the succession problem imperils not only the political continuity that any program of transition to Communism requires, but also endangers even the regime's capacity and determination to inflict permanent revolution on the Soviet people to effect Communism. 26 pp.

P-2387. On the consequences of a possible ozonosphere on Mars. G. F. Schilling. 7-28-61. Unclassified.

Data on the physical properties of the moon and planets. This paper shows that the existence of a possible ozonosphere on Mars, with its implications for processes of atmospheric heating and circulation, represents a major obstacle to correctly predicting the principal physical characteristics of the Martian atmosphere. 14 pp. Illus. Presented before the Symposium on Atmospheric Ozone at Arosa, Switzerland, August 9, 1961.

P-2388. The European coal and steel community. R. T. Nichols. 8-15-61. Unclassified.

An examination of the Treaty establishing the European Coal and Steel Community (ECSC), the purpose of which is to eliminate national influence from the coal and steel trades in six countries in Western Europe. The Treaty provides for the complete abolition of readily identifiable nationalistic trade barriers, such as tariffs, import quotas, subsidies, and discriminatory transport rates, within the Community. It also provides for the transfer of legal control over many aspects of the coal and steel industries—including, in particular, coal and steel prices—from the member governments to institutions of the Community. The principal institution of the ECSC is the High Authority, a supranational executive and lawmaking body. In practice, however, the High Authority has little power, because the individual member governments either retain or reassume the power of decision in all important matters. 38 pp. Tables.

P-2390. British defense policy: an American view. H. A. De Weerd. 8-3-61. Unclassified.

An examination of the continual changes occurring in British defense policy. The paper shows (1) the decisions made in the defense policy field and the reasons for these decisions, (2) the assumptions held about the likelihood of war, and (3) the future trends indicated in defense policy. 33 pp.

P-2391. On an invariant characterization of momentum-energy tensors for generalized media. D. G. B. Edelen. 8-24-61. Unclassified.

A study of momentum-energy tensors of generalized media, which are characterized by requiring such tensors to admit a unit time-like eigen-vector. It is shown that this eigen-vector is the velocity vector, and that the characterization leads to a direct description of Einstein-Riemann spaces in terms of fundamental statements of energetics. 9 pp.

P-2392-1. On some mathematical recreations. R. E. Bellman. 8-24-61. Unclassified.

An attempt to show how recurrence techniques, and dynamic programming techniques in particular, help to obtain the number of representations of different types and minimal representations. 8 pp.

P-2393. On the asymptotic behavior of solutions of nonlinear differential equations.

R. E. Bellman and J. M. Richardson. 8-1-61. Unclassified.

The title of this paper adequately describes its contents. 10 pp.

P-2394. Design of minimal weight structures for given reliability and cost. R. E. Kalaba. 8-3-61. Unclassified.

An improved computational procedure applied to a technique recently outlined by Hilton and Feigen for designing minimal-weight mechanical structures having a given degree of reliability. The considerations of Hilton and Feigen are generalized to include the costs of materials, 6 pp. Published in the *Journal of the Aerospace Sciences*, March 1962.

P-2395. Broadcasting from satellites. C. M. Crain. 8-3-61. Unclassified.

An examination of some general aspects pertinent to the use of satellites as an effective means of communication (namely, a definition of the term broadcasting, the parts of the radio spectrum that are potentially useful, the types of orbiting devices that can be considered, and the reception capability of the audience to be reached). The discussion deals primarily with satellites in an equatorial orbit that broadcast on TV, FM, and other high frequencies. 16 pp. Illus. Presented before the International Symposium on Space Communication at Paris, France, September 18-22, 1961.

P-2396. Economic aspects of communication satellite systems. S. H. Reiger and W. H. Meckling. 8-3-61. Unclassified.

An analysis, from an economic point of view, of the problems of cost and utilization in communication satellite systems. The discussion of system cost includes the cost of research and development, initial installation, and operation. The responsiveness of the market to increased transoceanic communication traffic is considered in terms of demand increase over a period of time and in terms of the sensitivity of utilization rates to price reductions. 18 pp. Illus. Presented before the International Symposium on Space Communication at Paris, France, September 18-22, 1961.

P-2397. The Sino-Soviet conflict over the transition to Communism. D. S. Zagoria. 8-7-61. Unclassified.

A discussion of the differences between Moscow and Peking over the question of domestic revolutionary strategy, i.e., the "transition to Communism." These differences arise over such issues as the question of timing, the communes, fundamentalism versus pragmatism, experimentation versus consolidation, and the applicability of the Soviet model for underdeveloped areas. Some of the causes of these differences are suggested: differing national circumstances, Maoist evangelism, and differing revolutionary histories. The implications of these differences for the world Communist movement are also examined. 25 pp. Published in *Soviet Survey*, October 1961.

P-2398. Minimal imbeddings and the genus of a graph. J. W. T. Youngs. 8-8-61. Unclassified.

An examination of the problem of characterizing minimal imbeddings, and of the calculation of the genus of a graph. It is practically obvious that a connected graph can be imbedded in an orientable 2-manifold. However, it is by no means obvious that, given an imbedding, there is no imbedding in an orientable 2-manifold of lower genus. If no such second imbedding is possible, the first is called a minimal imbedding, and the genus of the graph is defined to be the genus of the orientable 2-manifold in which the graph is minimally imbedded. 24 pp. See also P-2426 and P-2428.

P-2399. Detection of nuclear explosions. R. Latter, R. F. Herbst, and K. M. Watson. 8-2-61. Unclassified.

A review of the problem of detecting nuclear explosions, and a description of some of the more important aspects of the problem. Detection is discussed separately for each environment in which explosions could be undertaken—in the atmosphere, underwater, underground, and in space. The study focuses more on the underground and space environments than on the atmosphere and underwater environments, since the more difficult problems for detection arise in the case of underground and space nuclear explosions. 97 pp. Illus. Published in the *Annual Review of Nuclear Science*, Vol. 11, 1961.

P-2400. Mathematical model-making as an adaptive process. R. E. Bellman. 8-10-61. Unclassified.

A discussion of the feasibility (1) of formalizing the art of mathematical model-making and (2) of constructing machine programs for this purpose. 10 pp. Illus. Presented before the Symposium on Mathematical Optimization Techniques at Santa Monica, California, October 18-20, 1960.

P-2401. Approximate confidence limits for the reliability of series and parallel systems. Albert Madansky. 8-14-61. Unclassified.

Consideration of a reliability problem in which a complex mechanism (e.g., a missile) is built up from a number of different types of components, where the reliability of each of the components has been estimated by means of separate tests on each of the components. This paper gives a method for combining such data to determine approximate confidence limits for the reliability of the complete mechanism. More precisely, a method of determining approximate confidence limits for the reliability of "series," "parallel," and "series-parallel" systems is given, based on observed failures of the individual components. It is assumed that the failures are independent, and that failures of a given component follow a binomial distribution with unknown parameter, the component reliability. The large-sample properties of the likelihood-ratio test are then used to construct the appropriate confidence limits for the system reliability. 12 pp. Also published as RM-2552.

P-2402. A computational procedure for optimal control problems with state variable constraint. Yu-Chi Ho. 8-2-61. Unclassified.

A demonstration of a computation for optimal control problems with state variable constraint through a successive approximation procedure. A previous procedure for an optimal control problem has been developed with the use of terminal and in-flight constraints. The problem, stated in this paper, is equivalent to the earlier one. 11 pp.

P-2404-1. The use of quadratic programming in stochastic linear programming. E. M. L. Beale. 1-15-62. Unclassified.

A method of allowing for uncertainties in the constant terms (i.e., right-hand sides) of a linear programming problem, and hence of producing realistic "safety margins" in the solution. This is done by fitting a mixture of uniform distributions to the assumed distributions of these right-hand sides, and by using a particular quadratic programming algorithm. 25 pp. Illus. Presented before The Institute of Management Sciences at Brussels, Belgium, August 23-26, 1961.

P-2405. The simplex method using pseudo-basic variables for structured linear programming problems. E. M. L. Beale. 8-15-61. Unclassified.

A procedure for solving linear programming problems that consist of separate subproblems with a few linking variables that occur in all (or several) subproblems. This is the simplex method, organized so that the advantages of the special structure of the problem are preserved. 32 pp.

P-2406. World magnetic survey—introductory remarks. E. H. Vestine. 8-15-61. Unclassified.

Remarks consisting chiefly of abstracts from the author's monograph "A Manual of Instructions" published by the International Union of Geodesy and Geophysics. The manual attempts to summarize to date (1) the main technical findings of the Special Committee on World Magnetic Survey and Magnetic Charts and (2) other matters pertinent to a World Magnetic Survey, such as the nature of the geomagnetic field and its secular magnetic change. 7 pp. Incorporated in *Space Research II*, ed. by H. C. van de Hulst, C. de Jager, and A. F. Moore, North-Holland Publishing Company, Amsterdam, Netherlands, 1961. \$24.00. Presented before the Cosmic Rays and Geomagnetism session of the Committee on Space Research at Florence, Italy, April 12, 1961.

P-2407. Probability and statistics in systems work. I. S. Reed. 8-16-61. Unclassified.

The application of statistics and probability to systems work by way of an example. The system chosen to illustrate such applications of statistical design is a particular statistical decision mechanism, called the mechanized radar observer. The specific fields of statistics and probability used in the design of this machine are discussed. 37 pp. Illus. Presented before the Workshop on Systems Engineering in Electrical Engineering Education at the Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pennsylvania, August 31, 1961.

P-2409. An extension to VLF reflection coefficients. E. C. Field, Jr., P. Tamarkin, and E. M. Fairbrother. 8-17-61. Unclassified.

An extension to P-2249, *VLF Ionospheric Reflection Coefficients: Derivation from Impedance Concepts and Values for Some Model Ionospheres*. This paper presents formulas for very-low-frequency propagation at arbitrary directions in connection with the geomagnetic field. Sample numerical results are also displayed for all four reflection coefficients for propagation in the magnetic meridian. 7 pp. Illus. Published in the *Journal of Geophysical Research*, February 1962.

P-2410. An exposition of the equilibrium of the firm: symmetry of the product and factor analyses. Jack Hirschleifer. September 1961. Unclassified.

A discourse on an imperfect symmetry in the standard textbook presentation of the equilibrium of the firm. This imperfect symmetry arises between the analysis conducted in terms of product units and concepts and the analysis conducted in terms of factor units and concepts. This paper attempts to provide a more correct treatment of both product and factor units for the equilibrium of the firm, and indicates a rather significant ambiguity in the usual concept of marginal cost that has not received its due from textbook authors. 9 pp.

P-2411. Differential compatibility conditions on the momentum-energy tensor and necessary conditions for the existence of solutions to the Einstein field equations. D. G. B. Edelen and T. Y. Thomas. 8-21-61. Unclassified.

An examination of the third-order dynamic compatibility conditions derived in P-2369, *Discontinuities in the Einstein Field for General Momentum-energy Tensors*. It is shown (1) that three additional existence requirements are obtained for problems of the first class and (2) that existence requirements cannot be partially eliminated by an appropriate orientation of the discontinuity surface, since such orientations do not necessarily persist with time. 24 pp. See also P-2368-1. Published in *Archive for Rational Mechanics and Analysis*, May 1962.

P-2412. The relation of U.S. fallout casualties to U.S. and Soviet options. N. A. Hanunian. 8-18-61. Unclassified.

A discussion of the fallout hazard that would be created by a nuclear attack on the United States. Factors considered include (1) target choice, (2) attack weight, in terms of megatonnage delivered, (3) civil defense effectiveness, in terms of shelter and behavior, and (4) a tactical alternative, that of surface bursts versus airbursts. 28 pp. Illus. Published in *Civil Defense—1961, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, 1st Session, August 1, 2, 3, 4, 7, 8, and 9, 1961*. Presented before the Military Operations Subcommittee of the Committee on Government Operations of the House of Representatives, 87th Congress, at Washington, D.C., August 8, 1961.

P-2413. Ecological problems and postwar recuperation: a preliminary survey from the civil defense viewpoint. H. H. Mitchell, M.D. 8-21-61. Unclassified.

An assessment of ecological problems of the postattack environment, with emphasis on how disturbances caused by a nuclear attack will affect man's ability to exist because of possible failures in the biological-environmental complex. The paper evaluates such radiation hazards as the possibility of the soil becoming sterilized through the destruction of decomposers (bacteria and fungi), the inability of crops to grow, or the upsetting of population balance between two or more life forms because of differential radiosensitivity. 18 pp. Illus. Published in *Civil Defense—1961, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, 1st Session, August 1, 2, 3, 4, 7, 8, and 9, 1961*. Presented before the Military Operations Subcommittee of the Committee on Government Operations of the House of Representatives, 87th Congress, at Washington, D.C., August 7-10, 1961.

P-2414. Problems of fire in nuclear warfare. J. E. Hill. 8-21-61. Unclassified.

A study of the possible impact of fire in the event of a nuclear attack on the United States. In the author's opinion, fire damage need not be catastrophic in the sense of preventing postwar recovery from rather heavy nuclear attacks. Fire damage to urban areas is likely to be confined largely to areas seriously damaged by blast. Fire will not destroy the greater part of forests and rangelands, because the enemy would assign his weapons to military or urban targets, and the spread of fire from such targets to forest areas is unlikely to occur for the major portion of these targets. Before a possible attack many measures can be taken to reduce the fire damage and to aid in postattack recovery. 32 pp. Tables. Published in *Civil Defense—1961, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, 1st Session, August 1, 2, 3, 4, 7, 8, and 9, 1961*. Presented before the Military Operations Subcommittee of the Committee on Government Operations of the House of Representatives, 87th Congress, at Washington, D.C., August 8, 1961.

P-2415. Soviet civil defense. Leon Gouré. 8-22-61. Unclassified.

An attempt to ascertain the nature of the Soviet civil defense doctrine, the character and scope of the Soviet program, and the actual extent of its implementation. Some of the limitations and assumptions of the Soviet civil defense program are also suggested. Evidence indicates that the Soviet authorities are serious about civil defense and that they have been trying over a period of years to develop (within the limits of available financial, technical, and material resources) a significant civil defense capability. 25 pp. Illus. Published in *Civil Defense—1961, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, 1st Session, August 1, 2, 3, 4, 7, 8, and 9, 1961*. Presented before the Military Operations

Subcommittee of the Committee on Government Operations of the House of Representatives, 87th Congress, at Washington, D.C., August 7-10, 1961.

P-2416. Economic recovery from the effects of thermonuclear war. S. G. Winter, Jr.
8-22-61. Unclassified.

An outline of the problem of economic recovery from the effects of thermonuclear war. Assuming that the United States is involved in such a war, the author attempts to determine whether the population losses can be held essentially to those caused directly by the war and whether the nation can recover its prewar achievements in political organization, human welfare, and production. The paper discusses the range of possibilities occurring in the war, its three phases of recovery, and the capacity output needed in various industries to meet austere consumption requirements. 31 pp. Illus. Published in *Civil Defense—1961, Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, 1st Session, August 1, 2, 3, 4, 7, 8, and 9, 1961*. Presented before the Military Operations Subcommittee of the Committee on Government Operations of the House of Representatives, 87th Congress, at Washington, D.C., August 7-10, 1961.

P-2418. The use of local similarity concepts in hypersonic viscous interaction problems, and application to yawed lifting surfaces with mass transfer.
C. F. Dewey, Jr. 8-22-61. Unclassified.

An examination of the use of local similarity concepts as applied to the hypersonic viscous interaction problem. It is shown that the coupling between the viscous and inviscid flow regions near the body surface may be explicitly determined for all values of the interaction parameter X_∞ . The cases of $X_\infty \ll 1$ ("weak" interaction) and $X_\infty \gg 1$ ("strong" interaction) appear as asymptotic limits of the general formulation. The paper includes a large number of solutions to the similarity equations for various combinations of the surface temperature, surface mass transfer, pressure gradient, and sweep parameters. 69 pp. Illus. Presented before the American Rocket Society at New York City, October 9-14, 1961.

P-2419. On the reduction of certain multiplicative chemical equilibrium systems to mathematically equivalent additive systems. G. B. Dantzig and J. C. De Haven. 8-24-61. Unclassified.

A discussion of the vectorial formulation of the chemical equilibrium problem, represented by tableaux. This formulation provides a method for consolidating a large amount of fact and hypothesis relating to large chemical systems that involve reactions and states of complex molecules. The formulation, in addition to the associated techniques for minimizing the free energy of the entire system, allows equilibrium states under varying conditions to be calculated in a rapid and efficient manner on electronic computers. In biological systems, involving hemoglobin, for example, it is possible to account for and to compute the effects of simultaneous changes in pH, CO_2 , O_2 and metabolite concentrations on the oxygenation of hemoglobin. The effects of changes in temperature and total pressure may also be introduced into the model. 29 pp. Illus.

P-2420. The effect of pressure gradient on the hypersonic strong viscous interaction on a flat plate with surface mass transfer. Ting-Yi Li and J. F. Gross.
8-24-61. Unclassified.

An account of the development of an approximate theory to the problem of hypersonic strong viscous interaction on a flat plate with mass-transfer at the plate surface. The disturbance flow region is divided into inviscid and viscous flow regions. The hypersonic small perturbation theory is applied to the solution of the inviscid flow region. The method of similar solutions of compressible laminar boundary layer equations is applied to the treatment of the viscous flow region. The law of surface mass-transfer for similar solutions is derived. The pressure and the normal velocity are matched between the inviscid and viscous flow solutions. Formulas for induced surface pressure, boundary layer thickness, skin friction coefficient, and heat transfer coefficient are obtained. Numerical results show that increasing the value of the pressure gradient parameter reduces the effect of mass transfer on the interaction phenomena. 30 pp. Illus. German text also available. Presented before the German Aeronautical Society at Freiburg im Breisgau, Germany, October 10-14, 1961.

P-2421. Various properties of the Poisson distribution. G. F. Hadley and T. M. Whitin. 8-25-61. Unclassified.

A table of properties of the Poisson distribution that have been found useful in working with a variety of operational models. In particular, the properties have been of aid in obtaining explicit expressions for inventory levels, backorders, and stockout costs under various assumptions concerning the lead time distribution and penalty functions. 26 pp.

P-2422. The automobile—today and tomorrow. G. A. Hoffman. January 1962. Unclassified.

A prediction of future automobile characteristics, derived by examining each component of present-day automobiles in the light of emerging technical and economic pressures. The evolved components are reconstructed into possible vehicles of a decade or two hence, permitting a prediction of weights, capacities, performances, speeds, sizes, maneuverabilities, and initial and operating costs. 29 pp. Illus. Presented before the Highway Research Board at Washington, D.C., January 9, 1962.

P-2423. Sequential detection in radars with multiple resolution elements. M. B. Marcus and P. Swerling. 8-25-61. Unclassified.

The application of techniques of sequential analysis to a multiple-resolution-element search radar for different types of detection. By using sequential methods, such a radar shows considerable power savings compared with fixed-scan-rate detection radars. Problems occurring in sequential radar detection are examined, and the difficulties of obtaining analytical results for multiple-resolution-element sequential radars are discussed. Results are included that suggest that truncation is not necessary for the tests considered. Curves describing the improvement obtained by sequential detection procedures are also given. 39 pp. Illus. Published in the *IRE Transactions on Information Theory*, April 1962.

P-2425. Soviet views on the role of civil defense. Leon Gouré. 8-28-61. Unclassified.

A discussion of the reasons why Soviet leaders believe their civil defense program is an integral part of the Soviet defense posture, contributing directly to the country's readiness for war. Their postwar civil defense program has been in effect over ten years and has been expanded and accelerated since 1955. Its purpose is not only to ensure the physical survival of a substantial element of the population, but also to preserve civilian morale and provide for the rapid recuperation of the country from attack. In the event of a war, it becomes essential to ensure the survival of the administrative control and the industrial forces that may be expected to influence the further course of the war and possibly even to determine its outcome. 17 pp. Published in *Current History*, November 1961.

P-2426. Simplest imbeddings of the complete 12 graph. J. W. T. Youngs. August 1961. Unclassified.

An affirmative answer to an unsolved problem mentioned in P-2398, *Minimal Imbeddings and the Genus of a Graph*. The problem is: Is there a graph G with imbeddings $G(M)$ and $G(N)$ providing triangulations of M and N respectively, such that M is orientable and N is a non-orientable 2-manifold? 6 pp. Illus. See also P-2428.

P-2427. Finite nets—II: uniqueness and imbedding. R. H. Bruck. August 1961. Unclassified.

Proof that a collection C of t mutually orthogonal latin squares of side n can be completed in at most one nontrivial way if $n > (n - 2 - t)^2$. The author shows that C can always be completed if $n > \frac{1}{2}e^4 + e^3 + e^2 + \frac{3}{2}e$, where $e = n - 2 - t$. He also proves a number of other theorems giving sufficient conditions for a pseudo net-graph to be the graph of a uniquely defined net of given order and degree. 61 pp.

P-2428. Remarks on the genus of a complete graph. J. W. T. Youngs. August 1961. Unclassified.

A note concerned with finding bounds on $\gamma(K_n)$ for all n in a problem in which, by definition, $\gamma(K_n)$ —the genus of K_n —is $(n - 3)(n - 4)/12$. 7 pp. For definitions and background information, see P-2398 and P-2426.

P-2431. Spin susceptibility of normal fermion systems. R. M. Rockmore. 8-29-61. Unclassified.

The calculation of the induced spin density of a normal fermion system. The electron gas in the limit of small wave numbers is carried beyond the random phase approximation (R.P.A.) by the method of canonical transformation to include the first non-R.P.A. corrections. An expression for the induced spin density in the same limit exact to all orders of particle-particle coupling is then derived by more general methods of many-body perturbation theory. It depends only on the knowledge, to all orders of interparticle coupling, of the effective mass and the forward scattering of quasi-particles at the Fermi surface, and also yields the results of the extended R.P.A. on appropriate expansion. In the limit of zero wave number, the resulting expression for the magnetic susceptibility is found to be identical with that deduced by Landau from a phenomenological basis and may be considered an additional confirmation of the microscopic validity of the theory of the Fermi liquid. As an application, the magnetic susceptibility of a dense electron gas is calculated. The result disagrees with that obtained by Brueckner and Sawada, and the source of error in their calculation is discussed. 26 pp. Published in *Physical Review*, February 1962.

P-2432. Hiders and finders: an approach to inspection and evasion technology. A. H. Katz. 4-26-61. Unclassified.

An example of an experimental program which would develop U.S. evasion and inspection technology through actual practice and activity. Several pertinent aspects of such an active program are described. The need for skill in inspection and evasion techniques is discussed in connection with both unilateral action and future disarmament or arms control programs. 9 pp. Published in the *Bulletin of the Atomic Scientists*, December 1961.

P-2433. On local war doctrine. M. W. Hoag. August 1961. Unclassified.

An examination of doctrinal fundamentals that underlie various policy positions on limited war. The polar opposites of "Pure Massive Retaliation" and "Complete Graduated Deterrence" are contrasted and criticized, and the limiting process in local war is discussed. Differences among the official "New Look" of 1953, 1961, and (conjecturally) of 1965 are speculated about, and current open issues are listed. 26 pp. Illus. Presented before the Consultant Panel of the Operations Evaluation Group, Woods Hole, Massachusetts, June 15, 1961.

P-2434. The problem of detecting nuclear explosions. Richard Latter. 7-25-61. Unclassified

Testimony before the Joint Congressional Committee on Atomic Energy, July 25, 1961. The control system discussed at the Geneva test ban conference has a very limited capability to monitor nuclear weapons tests. For atmospheric and underwater tests, it has a good capability of detecting and identifying nuclear tests above about one kiloton. For underground tests, although large tamped explosions are detectable, large decoupled explosions are not. For space tests, unshielded explosions are detectable at great distances, but large shielded explosions are not. To improve detection, extensive research is needed on the means (1) to make decoupled underground explosions and shielded space explosions more detectable and (2) to perform on-site inspection of suspected underground events. Such research requires underground nuclear explosions and an expensive satellite program for measuring space radiations. 17 pp.

P-2435. Status prediction of scheduled equipment. R. E. Johnson and B. J. Marks. August 1961. Unclassified.

Consideration of the problem of predicting equipment status when movements of units of equipment from one state to another are governed not only by the transition probabilities of a Markov chain, but also by a control process that involves a form of scheduling. In scheduling, reassignments of equipment from certain states to others are planned for various future times. Because the number of units actually available for reassignment is a random variable, "expected reassignments" are used in determining equipment status at each successive stage in the prediction process. Expected reassignments are used to modify equipment status at the beginning of a period, and then the transition probabilities of a Markov chain are used to determine the status of equipment at the end of that period. By using the resulting predictions, a decisionmaker is in a position to evaluate the future performance of the system and to adjust his schedule accordingly. 37 pp. Illus.

P-2436. The computation of oblique shock wave characteristics for real gases. W. C. Strahle. August 1961. Unclassified.

A method of obtaining oblique-shock-wave data for real gases from real-gas normal-shock-wave data corresponding to the same upstream thermodynamic state. This method is useful only when the flow deflection angle is the specified parameter instead of the wave inclination angle. 14 pp. Illus.

P-2437. Development of a business language. S. L. Pollack. 9-5-61. Unclassified.

A progress report on the activities of the Language Systems Group, which is part of the Development Committee of CODASYL (Conference on Data Systems Languages). The CODASYL Systems Group believes that an effective method of systems analysis and description can be developed to introduce an advanced systems language. This systems-analysis method will (1) provide a precise and orderly means of documenting the analysis independent of the processing method, (2) aid in visualizing the relationships and alternatives of the problem, (3) provide flexibility in changing any portion of the analysis, and (4) establish a framework for the complete definition of the systems problem. 9 pp. Illus. Presented before the Fifth Electronic Business Systems Conference at Long Beach, California, October 27, 1961.

P-2438. How well do we know the Soviet Union? Leon Gouré. 9-7-61. Unclassified.

An article emphasizing the need for accurate assessments of Soviet foreign policy intentions and strategy. The more we know about Soviet intentions, the better prepared we shall be to win the ongoing struggle. In the meantime, while we go on trying to improve our knowledge and understanding of the Soviet Union, we cannot guarantee ourselves against errors in judgment or occasional surprises from unanticipated Soviet moves. The consequences of the shortcomings in our knowledge of the Soviet Union will be considerably mitigated if the West avoids accepting the passive role of responding to Soviet political initiative and instead pursues a consistent and dynamic policy of its own. 14 pp. Published in *The New York Times Magazine*, October 1, 1961.

P-2439. Comments on an article by Chas. E. Osgood, "A psychologist's cure for the arms race." A. H. Katz. November 1961. Unclassified.

A discussion of some of the basic assumptions of Charles Osgood's article, "A Psychologist's Cure for the Arms Race," which appeared in the November, 1961, issue of *War/Peace Report*. Amrom Katz questions Osgood's suggestions that increases in arms do not yield security and that probabilities of the ways nuclear war could start are cumulative. A proposal worthy of investigation, according to Katz, is that of attempting to match deeds, not announcements, of military potential or to file off the raw edges of our military posture in such a way that invites response (hopefully of a similar character) by the Soviets. 6 pp.

P-2441. Satellite charge-up in the outer Van Allen belt. R. O. Hundley. September 1961. Unclassified.

A discussion of satellite charge-up in the outer Van Allen belt. Because of the presence of the high-energy Van Allen electrons, the electrostatic potentials acquired by satellites in the Van Allen region may be much larger than for the case of ionospheric satellites. Numerical results for the satellite potential are obtained under the assumption of complete absorption of the incident particles. It is found that for satellites of the size used thus far, potentials of a few kilovolts can be expected, but that for satellites of larger size, potentials up to several tens of kilovolts can be expected. The effects of secondary electron emission and photoelectron emission are investigated. The paper shows that secondary electrons will have only a minor effect, but that for some surface materials the effect of photoelectron emission due to solar radiation may completely cancel out the large potentials. 35 pp. Illus.

P-2442. The resolution of cognitive conflict under uncertainty: a critique. Nehemiah Jordan. September 1961. Unclassified.

A critique of two experiments presented by Zajonc and Burnstein in the May 1961 issue of *Human Relations*. Both experiments concern the resolution of conflicts (discrepancies) between prior information or knowledge and new information in the form of messages. In both experiments the degree of certainty of the prior information is varied, i.e., is the independent variable. 5 pp.

P-2444. Perception, cognition, and science. Nehemiah Jordan. September 1961. Unclassified.

A discourse on Brunswik's description of what must occur in the perceptual process. It seems improbable that this description will be found to be incorrect in the future, though with the increase of factual knowledge and conceptual sophistication, many additional details may be added to it. The power of this description is such that it can be used to develop a chain of thought that is in many ways in opposition to Brunswik's assumptions concerning knowledge and science. This paper attempts such a development. 37 pp. Illus.

P-2445. The role of the accountant in operations analysis. Eugene Ladin. September 1961. Unclassified.

An attempt to provide a conceptual understanding of operations analysis and of the role that the accountant can play in this field. As more emphasis is shifting to operations analysis in the commercial world, this concept will have a definite impact on the accountant. The accountant must re-orient his perspective by looking at the future rather than only at the past, must become familiar with the methodology of operations analysis so that he can become an effective member of the operations analysis team, must develop a library of cost factors by organizational functions for the anticipated variables that will be inserted into the models, and must design accounting systems so that these factors can be determined and the variables controlled. 13 pp. Published in *The Accounting Review*, April 1962.

P-2446. Some simplex-like nonlinear programming procedures. P. S. Wolfe. September 1961. Unclassified.

A comparison of four computational techniques, based on the simplex method, for solving nonlinear programming problems. The author describes columnar procedures in nonlinear problems, separable programming, the decomposition procedure, and the cutting-plane method. 18 pp.

P-2447. Systematic methods for programming simplification. R. L. Van Horn. September 1961. Unclassified.

A discussion of the difficulties involved in implementing large-scale data systems. With the advent of new concept systems, research on the implementation process is badly needed. These systems have serious problems of extended development cycles, personnel and policy changes, rapid hardware development, great masses of detail, and very complex testing requirements. Techniques for the efficient use of computers are examined, together with some ways in which management can assist systems people. 22 pp. Presented before the Fifth Electronic Business Systems Conference at Long Beach, California, October 25-27, 1961.

P-2448. The firm's cost function: a successful reconstruction? Jack Hirschleifer. September 1961. Unclassified.

An evaluation of a reconstruction of the firm's cost function proposed by Armen Alchian in P-1449, *Costs and Outputs*. The relevance of this reconstruction is examined for a variety of different situations. The study also shows how the reconstruction can be reconciled with the orthodox model. Professor Alchian argues that there is a characteristic and explainable difference between the way total cost changes in response to variations in the rate dimension and the way it responds to variations in the volume dimension of output. 46 pp. Illus.

P-2449. Operations useful for similarity-invariant pattern recognition. W. L. Doyle, Jr. September 1961. Unclassified.

Some ideas for position- and size-invariant two-dimensional pattern recognition. These ideas are natural extensions of the two-dimensional auto-correlation function to the set of all similarity transformations. An application to detection of straight lines is proposed. 15 pp. Illus.

P-2450. Partially controllable random walk. T. M. Cover. September 1961. Unclassified.

A study of a partially controlled random walk problem, which is viewed as a sequence of fair gambles on a nonlinear utility function. It is shown that with certain betting sequences a certain higher utility $U(x)$ can be associated with each point x , where $U(x)$ is now the expected utility at the end of the betting sequence beginning with capital x . The problem is also examined where the control process is limited to N stages of control (bets). It is concluded that betting policies that act as if each bet will be the last, will not generally be optimal. 29 pp. Illus.

P-2452. Possible economies through electronic data processing. E. F. R. Hearle. 10-9-61. Unclassified.

A discussion about municipal data processing and how electronic equipment can and should be used to provide for municipal economies. It is emphasized that the economies possible through the use of electronic data processing depend directly on the extent to which municipal officials are able to specify the precise role of data in city operations. Until recently, it was sufficient to concentrate solely on the use of data in clerical applications. From now on, cities must also improve the use of data in management decisions. 10 pp. Presented before the League of California Cities Annual Conference at San Francisco, California, October 23, 1961.

P-2453. Throw-away maintenance policies. C. F. Bell, Jr. October 1961. Unclassified.

An examination of those areas in which a choice exists between the policies of throw-away and of repair or renewal. The advantages and disadvantages advanced in support of each policy are listed, as well as the important parameters to be considered in arriving at policy decisions. These listed items are then ranked according to their apparent significance. Finally, the author discusses the establishment of desirable policies or specifications, or at least the necessary considerations prior to such establishment. 3 pp. Presented before the American Society for Quality Control at Philadelphia, Pennsylvania, October 24, 1961.

P-2454. Can EDP be applied to all police agencies? E. F. R. Hearle. 10-1-61. Unclassified.

An attempt to determine whether EDP (electronic data processing) can be applied to all police agencies. The author discusses the nature of the data-processing job facing law enforcement agencies, the equipment available now and in the future for handling this job, and what police departments can and should do now about EDP. It is a powerful tool that offers great promise to law enforcement officials. Its effective use depends in large measure on the extent to which police administrators specify the role of data in police operations and work together in the development of a cooperative and comprehensive system of data describing persons and property. 12 pp. Published in *The Police Chief*, February 1962. Presented before the League of California Cities at San Francisco, California, October 23, 1961.

P-2455. Information retrieval: a look at the logical framework and some new concepts. M. E. Maron. October 1961. Unclassified.

A discussion of the problems and prospects for automatic information retrieval systems. Weighted index tags allow for computing a measure of relevance to an information request. Statistical techniques aid in automatically relating and associating documents on the basis of their subject content. However, further strides should be made (1) in allowing the machine to identify documents on the basis of its "knowledge" of the complete text and (2) in a better understanding of the processes that lie behind intelligent problem solving. 37 pp. Presented before the American Records Management Association at Los Angeles, California, October 9, 1961.

P-2456. The thermodynamic properties of 85% CO₂ and 15% nitrogen to 24000°K. W. C. Strahle. September 1961. Unclassified.

A presentation of the equilibrium thermodynamic properties of a volumetric mixture of 85% carbon dioxide and 15% nitrogen over the temperature and pressure ranges of from 1000°K to 24000°K and 10⁻⁴ to 10² atm, respectively. It is expected that the prime use of these properties will be in preliminary design studies for probes to enter the Venus atmosphere. 28 pp. Illus.

P-2457. Beginner's FORTRAN. A. F. M. Sweetland. October 1961. Unclassified.

A paper indicating the many difficulties experienced by beginners with FORTRAN. This compiler routine consists of some 60,000 instructions. FORTRAN problems are presented, flow diagrams and the logic of testing are discussed, and a simplified approach to inputs, outputs, and card layouts is explained to help programmers. 68 pp. Illus.

P-2458. What to do about teacher shortages. R. N. McKean and J. A. Kershaw. November 1961. Unclassified.

A suggestion for alleviating the shortages of teachers in particular teaching fields. School districts must adopt a new kind of salary schedule that allows salaries for relatively scarce teaching skills to be raised, without simultaneously being compelled to pay higher salaries for all teaching skills. The authors urge that boards of education, school administrators, and other citizens adopt addi-

tional salary differentials, seriously weighing the potential gains against the difficulties. Such a step is essential if individual districts and the nation as a whole are to provide adequate education at acceptable costs. 15 pp. Illus.

P-2459. Human factors aspects in maintainability. Nehemiah Jordan. October 1961.

Unclassified.

An examination of the major interdependent subareas of maintainability and of their relation to human-factor problems. The subareas considered are (1) design for maintainability, (2) training the maintenance man for the responsibility of maintaining the equipment, and (3) the tools, equipment and/or aids that are necessary to enable the maintenance man to meet his responsibilities. 11 pp. Presented before the American Society for Quality Control Product Maintainability at Philadelphia, Pennsylvania, October 24-25, 1961.

P-2460. Statistics on the first six million prime numbers. F. J. Gruenberger and G. W.

Armerding. October 1961. Unclassified.

Tables giving some statistics on the first six million prime numbers. The first table shows the distribution of differences between successive primes, as well as the first occurrence of each difference. Another table exhibits every difference greater than 100 with the lower prime of the pair being printed. The third table shows specific information for every 50,000 natural numbers, and the fourth table displays explicitly the lowest prime of each four having a 2,4,2 difference pattern. The final table lists the number of occurrences of twin primes in each range of 100,000 natural numbers. 145 pp. Tables.

P-2461. By automobile through Western Russia. E. C. De Land. October 1961. Unclassified.

An account of an automobile ride taken by the author and his wife through Western Russia. Their route proceeded from Helsinki to Vyborg, to Leningrad, to Kalanin, to Moscow, to Kursk, to Kharkov, to Kiev, to Lvov, and then to Czechoslovakia and Poland. The Russians are described as being essentially and culturally different from West Europeans and Americans. From the underlying tensions of the trip, the author was glad at the end of the excursion to return to the free world. 67 pp.

P-2462-1. Science and statecraft. B. C. Denny and E. G. Mesthene. January 1962. Unclassified.

An investigation of ways in which the scientific component of policy can be most effectively exploited for the national security and welfare. The explosion of the first atomic bomb and the launching of the first artificial earth satellite testify to the impact of science on government. Some outstanding problems in formulating national security policy result in a reciprocal usurpation of the scientific and policymaking functions. Substantial improvements in existing policy instruments will require mutual realization by the scientist and policymaker that what each needs is to learn the other's job but only for the purpose of doing his own job better. 15 pp.

P-2463. Aggregation of magnitude judgments. R. C. Kao. October 1961. Unclassified.

An examination of the problem of aggregation of magnitude judgments by a group of individuals of the same set of stimuli. Necessary and sufficient conditions for the existence and the uniqueness of minimum-variance solutions are given for both ratio and interval scales. The computations needed for obtaining these solutions are also discussed. 31 pp.

P-2466. The use of war games in command and control analysis. M. G. Weiner. October 1961. Unclassified.

A description of a technique for examining command and control problems. This technique analyzes the command and control aspects of previously played limited war games. 12 pp.

P-2467. Appraisal of laboratory simulation experiments. M. A. Geisler. October 1961. Unclassified.

A discussion of the usefulness and applicability of the research developed during the past five years in RAND's Logistics Systems Laboratory. The author describes the circumstances that led to the creation of the laboratory, the problems undertaken, and the cost and time involved in each problem. The need is stressed not only for a closer tie between simulation and analytic techniques, but also for more recognition to problems of implementation. 10 pp. Published in *Management*

Science, April 1962. Presented before the Eighth Annual International Meeting of The Institute of Management Sciences at Brussels, Belgium, August 24, 1961.

P-2468-1. A macro investment model for manufacturing. J. H. Niedercorn. February 1962. Unclassified.

The derivation, statistical testing, and evaluation of a new investment model for investment in manufacturing industries. It is called an evolutionary model because it is based on some fundamental assumptions about the evaluation of the economy over time. With the help of a few additional assumptions, two macro investment functions are deduced from the model. They show that aggregate investment depends on the rate of growth of total output, the gap between desired and actual capital stock, and a change in profit variable to show the state of short-run expectations. 23 pp. Tables.

P-2469. Studies in economic planning: a trip report. F. T. Moore. October 1961. Unclassified.

An account of a recent trip to attend an economic conference in Geneva, Switzerland, and to talk with various people in Paris and London about European attitudes toward foreign aid, economic integration, and domestic economic planning. There is a rapidly growing body of theoretical and empirical work and actual experience in the use of economic planning for guiding growth and development within a democratic political government. The author feels that the United States should not miss the opportunity of benefiting from this experience and of incorporating it in thinking about its own problems. 19 pp.

P-2471. Probability and the library problem. M. E. Maron. January 1962. Unclassified.

A discussion of the information explosion in technical literature and of the resulting information retrieval problem. Certain aspects of this problem are considered, as well as areas of application of an automatic storage and retrieval system. An "ideal" automatic storage and retrieval system is then examined, followed by a description of the technological and conceptual implications of such a system. 21 pp.

P-2472. Imbalance in balance "theory." Nehemiah Jordan. November 1961. Unclassified.

Comments on two papers dealing with balance theory, which appeared in the Summer 1960 issue of *Public Opinion Quarterly*. The first paper by Charles Osgood reviews the theories of cognitive consistency and balance. Robert Zajonc, the author of the second paper, evaluates the work on psychological consistency in less technical terms and questions the universality of the drive to reduce cognitive dissonance. These two papers are assumed to adequately represent the tenor of research and thinking on this topic by academic psychologists. The thesis of the present paper is that this tenor leaves much to be desired. 20 pp.

P-2473. A brief review of mass transfer cooling. J. P. Hartnett. January 1962. Unclassified.

A review of the latest developments in mass transfer cooling wherein a foreign gas or liquid is transferred from the vehicle surface into the surrounding boundary layer. 24 pp. Illus. Presented before the Conference on International Studies of Heat Transfer at Paris, France, June 19-23, 1961.

P-2474. COSPAR international reference atmosphere. H. K. Kallmann-Bijl. November 1961. Unclassified.

An address before the National Academy of Sciences, telling of a cooperative effort by scientists of many nations, which resulted in the publication by COSPAR of an international reference atmosphere. 7 pp. Illus. Incorporated in *CIRA 1961* by H. K. Kallmann-Bijl, published by North-Holland Publishing Company, Amsterdam, Netherlands, 1961. \$3.00.

P-2476. A systems engineering approach to reliability. A. W. Boldyreff. November 1961. Unclassified.

Reliability approached as a problem of designing reliable systems using existing and, therefore, none too reliable components. Principal areas of concern to a reliability engineering organization are listed, as well as some general methods of increasing system reliability. Types of redundancy in system design are given. 10 pp. Presented before the Eleventh National Conference of the Aircraft

and Missile Division of the American Society for Quality Control at Los Angeles, California, November 9, 1961.

P-2477. The mesosphere. E. S. Batten. October 1961. Unclassified.

An article prepared for the 1962 *Yearbook of the McGraw-Hill Encyclopedia of Science and Technology*. The author summarizes knowledge and theory of the mesosphere as of 1961. 9 pp. Illus.

P-2478-1. Khrushchev's attack on Albania and Sino-Soviet relations. D. S. Zagoria. November 1961. Unclassified.

A discussion of the reasons for Khrushchev's open attack on the Albanian Party leadership (which was, of course, an attack on the Chinese Communist leadership as well) at the 22nd Party Congress in October 1961. The significance of this renewed pressure on Peking and its likely consequences are also examined. The possibility exists that Khrushchev's attack on Albania will lead to a public break with China, thus bringing out into the open a conflict that has become increasingly intense over the past several years. The situation is by no means irretrievable, however, and it must be assumed that both sides are extremely anxious to avoid an open split that would prove disastrous to both, but particularly to China. 33 pp. Published in *The China Quarterly*, October-December 1961.

P-2479. Aviation and international relations. Hans Heymann, Jr. November 1961. Unclassified.

A discussion of some misconceptions concerning the link between U.S. commercial aviation and the nation's military security and concerning the contribution of aviation supremacy to our national prestige. The author considers what will be demanded of aviation in the 1960's if it is to become a vital, constructive element in our international relations. Three U.S. foreign policy aims are presented, together with the challenges they pose for civil aviation. These policy aims are (1) to promote a high and sustained rate of overall growth in the United States and throughout the advanced industrialized world, (2) to strengthen the cohesion and solidarity of the Western Alliance, and (3) to create a new community of interest with the less-developed countries of Asia, Africa, and Latin America. 14 pp. Presented before the Symposium on the Issues and Challenges of Air Transportation at Hartford, Connecticut, November 2, 1961.

P-2480. The Soviet Union and the political uses of outer space. A. L. Horelick. November 1961. Unclassified.

An examination of the political objectives of the Soviet space program, a major element in the total strategy of Soviet leadership. Middle-term objectives are emphasized, as distinct from immediate ones of a largely tactical nature and from ultimate ones of a very broad and generalized character. No analysis of the political uses of the Soviet space program can ignore the impressive technological foundation upon which the Soviet Union has built its prestige and rested its sputnik diplomacy. Scientific and technological achievements do not automatically yield political victories. They must be consciously harnessed to the overall political strategy of the side seeking to exploit them, and used imaginatively in conjunction with other instruments of policy to achieve integrated goals. 43 pp. Published in *Air Force and Space Digest*, April 1962. Presented before the Seminar of the Foreign Services Institute at Cape Canaveral, Florida, January 23, 1962.

P-2482. Political negotiation as a process of modifying utilities. F. C. Iklé and N. C. Leites. November 1961. Unclassified.

A study of political negotiations and of their relation to other bargaining processes. A formalization is attempted for use in constructing a theory of negotiations. Propositions from the literature about actual negotiating behavior or about "good" negotiating techniques are reformulated. This formalization will be successful if reformulation makes the propositions more precise without depriving them of their significance for the reality to which they were addressed. At a later stage, such reformulations may be used to ascertain with empirical data in what situations or to what extent the propositions apply and to develop new propositions on the basis of data from actual negotiations. 25 pp. Illus. Published in *The Journal of Conflict Resolution*, March 1962.

P-2483. Secondary schools and computing. F. J. Gruenberger. November 1961. Unclassified.

A paper emphasizing the importance of teaching computing at the high school level. The introduction of computing technology and of the computers themselves in secondary schools seems analogous

to the learning of a foreign language, which is best taught to the young. Since computing skills cut across every discipline, the college-bound student should be prepared for intelligent use of this tool prior to his college freshman year. Although much effort will be devoted to this problem during 1962, the real wave of computing courses in secondary schools will probably not come until 1963 or later. 4 pp.

P-2486. Air transport and economic development: some comments on foreign aid programs. Hans Heymann, Jr. 12-8-61. Unclassified.

A description of the general nature of the U.S. aviation involvement with underdeveloped countries. Some of its consequences are examined, and a few of the special problems that the air transport function poses for the pursuit of economic development objectives are considered. Despite the fact that air transport does not presently receive much attention in our aviation assistance projects, the author indicates the development potentialities of the aviation instrument as well as its potentialities in the role of "market creator." 16 pp. Presented before the American Economic Association at New York, New York, December 28, 1961.

P-2487. The design of a sequential test for the detection of known signal in normal nonwhite noise. Ivan Selin. November 1961. Unclassified.

An examination of the design of a sequential test for signals in correlated normal noise. Both discrete and continuous time parameters are considered. The noise is assumed to be stationary in the continuous case, but not in the discrete case. Through the transformation of random variables, it is shown that the test of given strength that minimizes expected test length is Wald's sequential probability (likelihood) ratio test. 13 pp.

P-2488-1. Behavior of the firm subject to external regulatory constraint. H. A. Averch and L. L. Johnson. March 1962. Unclassified.

An attempt to develop a theory of the monopoly firm seeking to maximize profit, but which is subject to a constraint on its rate of return. This model is then applied to the domestic telephone and telegraph industry. As the firm does not equate marginal rates of factor substitution to the ratio of factor costs, it operates inefficiently in the sense that (social) cost is not minimized at the output it selects. The firm has an incentive to expand into other regulated markets, even if it operates at a (long run) loss in these markets. Therefore, it may drive out other firms, or discourage their entry into these other markets, even though the competing firms may be lower cost producers. In applying the analysis to the telephone and telegraph industry, it is found that the model does contribute to understanding market behavior. 25 pp. Illus.

P-2489. The journey-to-work as a determinant of residential location. J. F. Kain. December 1961. Unclassified.

Data on the manner in which transportation costs influence the household's choice of a residential location. A residential location model is also described that considers this problem somewhat differently than previous models. It is shown that households substitute journey-to-work expenditures for site expenditures. This substitution depends primarily on household preferences for low-density as opposed to high-density residential services. 40 pp. Illus. Presented before the Regional Science Association at New York, New York, December 27-29, 1961.

P-2491. Russian transliteration: sound and sense. R. L. Neiswender. November 1961. Unclassified.

A discussion of the predicament of the researcher when verifying Slavic names and titles referenced in foreign and American publications. The author indicates the need for a universally accepted system of Russian transliteration, describes the controversy over transcription versus transliteration, and examines the efforts of international organizations to adopt a universal standard. The unified Anglo-American system, which has now been widely accepted, is called the BSI system. 8 pp. Table. Published in *Special Libraries*, January 1962.

P-2492. Data processing for cities. E. F. R. Hearle and R. J. Mason. February 1962. Unclassified.

Suggestions on ways cities could improve the efficiency of routine data processing activities and the performance of their basic functions. The paper describes (1) the activities carried out in a data system, (2) the equipment available now and in the foreseeable future for facilitating these activi-

ties, (3) the nature of municipal data, (4) the design and mechanization of municipal data systems, and (5) the selection of data processing equipment. 50 pp.

P-2493. The 22nd Congress of the CPSU: some domestic implications. Oleg Hoeffding. December 1961. Unclassified.

A discourse on the 22nd Congress of the CPSU, which is described as a congress preoccupied with reshaping the past and denouncing the failings, errors, and crimes of the Party's past leaders. The paper examines the agenda of the congress and its outline of the size and structure of the Soviet economy between 1970 and 1980. The agenda deals not only with the blueprint for building the material base of Communism, but also for a decisive phase in the transformation of man to make him fit for life in Utopia. 12 pp. Presented before The Brookings Institution Seminar on the 22nd Communist Party Congress at Washington, D.C., December 1, 1961.

P-2494. Seeking social welfare facts in a California county: Sacramento. V. D. Bornet. December 1961. Unclassified.

An address presented before the Citizens' Welfare Advisory Committee of Sacramento County, December 5, 1961. Data and advice are given on the over-all social welfare problems faced in Sacramento County. Social welfare is defined as special services supplied and material assistance given by all or part of society to a human being thought to be in need. A list is given of the subjects suitable for social welfare research and other activities that should be excluded. The paper emphasizes the need of such fact-finding groups as the Citizens' Welfare Advisory Committee. 13 pp.

P-2495. Decisions, communication, and organization. James Farmer. December 1961. Unclassified.

A paper presented to a Seminar in Organization Theory at the University of California at Los Angeles in December, 1961. The use of mathematical models in the theory of organization is discussed. Authority relationships are used to develop a canonical form of organization, and communication constraints on the canonical form are shown. A stratified organization, used when a canonical form cannot be used to satisfy the constraints, is described. Organizational effects of varying communication load and a sequential decision process model are presented. 29 pp. Illus.

P-2496. Some theorems concerning the motion of an electrically charged particle in a dipole magnetic field. E. C. Ray and J. E. Kasper. December 1961. Unclassified.

Various theorems related to the application to cosmic rays of the theory of the motion of an electrically charged particle in a dipole magnetic field. The theorems are essentially those conjectured by Schremp. In making the proofs, the so-called trajectories of the first and second kinds are assumed to have certain properties in the large. These properties can be verified numerically and by series expansions in any particular case. 28 pp. Illus.

P-2497. Automatic data-processing for production control. L. S. Hill. December 1961. Unclassified.

A synthesized procedure for control of production using punched-card methods. The system may be considered a framework for application to any manufacturing enterprise engaged in the fabrication and assembly of parts, regardless of product. Machines are used to record and coordinate all paperwork involved in manufacturing from time of raw material receipt through transformation into finished product. The paper also indicates that mechanization of the production control system is a logical role for the industrial engineer. 20 pp. Table.

P-2498. Some simple examples of singular detection of continuous signals in noise. Ivan Selin. December 1961. Unclassified.

A discussion of the assumption—concerning the statistical detection of continuous signals in noise—that the boundedness of the expected value of the likelihood ratio is both a necessary and sufficient condition that the detection be nonsingular. The necessity of this condition is shown, but examples are given to demonstrate that the condition is insufficient unless the additional requirement is also imposed that the noise process be regular. In particular, processes with band-limited or exponential spectra are singular and should be avoided as models of background noise. 7 pp.

P-2500. A short table of prime numbers. G. W. Armerding and F. J. Gruenberger. December 1961. Unclassified.

A list of the first 9500 prime numbers (considering unity as a prime), together with an index number (from 1 to 9500). 39 pp. Table.

P-2501. Recovery of the Bendegó meteorite. P. M. Sears. January 1962. Unclassified.

A description of the recovery of one of the largest known meteorites. The great mass of the specimen, its inaccessibility, and the means of transportation available at the time made moving it a difficult task. 16 pp. Illus.

P-2502. Some statistical properties of selected inventory models. M. A. Geisler. December 1961. Unclassified.

A discussion of inventory policies in which not only the mean values of such important random variables as number of shortages per time period are studied, but also their variance and covariance properties. Such additional properties may help in interpreting the stability of an expected value, under assumed inventory policies and parameters, and in using stochastic or Monte Carlo models to calculate estimates of the expected values by sampling techniques. This paper examines comparatively simple inventory models and derives the expected value, variance, and selected covariance and correlations of the random variables representing stock on hand, shortages per period, overages per period, and reorder quantity. 30 pp. Table.

P-2508. Japan and her Soviet neighbor during the interwar years: Japanese images and reactions. P. F. Langer. December 1961. Unclassified.

Observations on the Japanese image of Russia during the interwar years. This analysis is largely confined to views held by the Japanese elite and by articulate members of the general public. Emphasis is on the 1920's rather than on the 1930's. Russia to the Japanese has meant vastness and power. No foreign threat has been as persistent, as serious, or as concrete as that posed by Russia. The Japanese have felt contempt and superiority toward Russia because of the latter's backwardness and lack of refinement. Furthermore, the Bolshevik Revolution was considered a source of dangerous infectious disease. However, the Russian threat was felt long before the establishment of the Soviet regime. It acquired greater depth and intensity with the added menace of Communism. 20 pp.

P-2509. Lord Russell, unilateralism, and the Labour Party. H. A. DeWeerd. January 1962. Unclassified.

A review of the Campaign for Nuclear Disarmament, a pacifist-neutralist movement trying to force Britain's withdrawal from the world of alliances and power politics. The movement is using the prestige of Bertrand Russell to help sell its program to a politically illiterate fringe of the English population. The movement claims to be nonpolitical, but until recently has acted as if it were trying to use the Labour Party to implement its program. Thus far, the unilateralist leaders have convinced only a small number of Englishmen of the wisdom of their program, of their consistency, or of their honesty. 27 pp.

P-2510. Determinants of productivity change in United States manufacturing. B. F. Massell. January 1962. Unclassified.

A discussion of the forces underlying a trend that shows a significant rise in output per man-hour in all major segments of the U.S. economy during the past forty years. Capital deepening and technical advance are suggested as the two agents responsible for productivity change, and estimates of their relative significance are presented. Technical change is, in turn, broken down into an inter-industry and an intraindustry component, and the observed improvements in technology are allocated between the two. Finally, the distinction is drawn between autonomous and induced shifts in the production function, and an attempt is made to gauge their relative importance in the manufacturing sector. 70 pp. Illus. See also P-2088-2 and P-2090-2.

P-2511. Scheduling state of the art—anathema or necessity? F. S. Pardee. November 1961. Unclassified.

An examination of the meaning of statements concerning the rate of technological advancement and their implications for R&D planning. The author defines the terms "research and development" and "state of the art," distinguishes between scheduling and predicting, and summarizes the pros and cons of the argument about scheduling state of the art. It is concluded that the nature of state-of-

the-art scheduling should be a function of the phase which the research and development program is in. Emphasis should be on comprehensive planning of a series of alternative courses of action. The process should be flexible in order to assess alternative actions and to modify the program. In later phases of R&D, the range of alternatives to be examined probably will be more limited, and considerable specification of the plan should be stressed to ensure integrated and timely compliance. 13 pp. Presented before a joint meeting of the Operations Research Society of America and The Institute of Management Sciences at San Francisco, California, November 8-10, 1961.

P-2514. Linear programming. R. C. Kao. January 1962. Unclassified.

A talk given on linear programming, a mathematical technique that has enjoyed a flourishing growth since 1947, both in theory and in application. The paper discusses the role of linear programming in solving the optimal diet problem, the theory of linear systems, theories relating to the computational aspect of linear programming and some linear programming applications. 14 pp. Presented before the Mathematics Symposia for 1961-1962 at Pasadena, California, January 9, 1962.

P-2516. Meteorological rockets step upward. W. W. Kellogg. January 1962. Unclassified.

An outline of the exploration of the mesosphere. The so-called forgotten region below the ionosphere, but above the reach of instrumented balloons, has been studied only for limited periods, and over limited areas. Because of the possible effects of mesospheric activity on the lower atmosphere, study is being broadened through the meteorological rocket network. A still wider front of exploration is needed. 6 pp. Presented before the American Meteorological Society at El Paso, Texas, December 6, 1961.

P-2517. A brief review of inventory theory. M. A. Geisler. January 1962. Unclassified.

A summary of the main results obtained on inventory theory to describe its current status. The paper considers deterministic and probabilistic inventory models, distinguishes between one-period and *N*-period models, and stresses the implications of the state of inventory theory. This theory provides solutions to a wide class of inventory problems, and the effective use of these techniques can do much to introduce greater rationality and efficiency into inventory management. 11 pp.

P-2520. The inhuman style. D. H. Scott. February 1962. Unclassified.

An analysis of jargon as a parody of the scientific method. Those who write it suffer from the delusion that prose is good to the degree that it is inhuman. As a result, their style is pretentious, impersonal, and irresponsible in language and ideas. 3 pp. Illus. Published in *The Technology Review*, February 1962.

P-2521. Quality control and reliability for total weapon system. E. E. Bean and W. A. Steger. January 1962. Unclassified.

A useful technique for evaluating Air Force ballistic-missile weapon systems. A detailed computer-assisted simulation experiment, modeled on an entire weapon system, is described. The technique, used in the RAND Logistics Systems Laboratory, is then studied as a device for obtaining weapon-system-oriented decisions on allocating quality control budgets between alternative uses in a given system. 21 pp. Illus.

P-2522. Western Electronic Show and Convention (WESCON), San Francisco, California, 1961. M. M. Hatch. February 1962. Unclassified.

An account of the WESCON meeting held August 22-25, 1961, under the joint sponsorship of the Institute of Radio Engineers and the Western Electronic Manufacturers Association. The paper includes discussions of two noteworthy addresses, the arms-control panel session, the technical sessions, the field trips, and the exhibits. A list of 25 available preprints of technical papers presented at WESCON is also included. 40 pp.

P-2524. A note on the national accounts of Algeria, 1950-1959 and 1964. Harold Lubell. January 1962. Unclassified.

Tables showing the figures on most of the national accounts flows for Algeria for 1950 through 1959 and for 1964. The tables present the gross national product account, the personal income account, the government revenue and current outlay account, the combined capital account, and the balance of payments account. 12 pp. Tables.

P-2531. The maximum connectivity of a graph. Frank Harary. February 1962. Unclassified.

An attempt to determine the maximum connectivity of any graph with a given number of points and lines. The minimum connectivity, the maximum diameter, and the minimum diameter are also obtained. The paper concludes with two unsolved problems concerning the distribution of the values of the connectivity and the diameter. 14 pp. Illus.

P-2533. Urban economic accounts and research: a comment. F. T. Moore. February 1962. Unclassified.

Comments on two papers delivered before the American Economic Association at New York, December 27, 1961. Both papers (one by Dr. Harvey Perloff and the other by Prof. Werner Hirsch) attempt to increase the extent and type of information collected on urban and regional affairs. Hirsch has specific suggestions for accommodating the information in a single framework, whereas Perloff suggests proceeding on four interrelated fronts. 4 pp.

P-2534. A complementary problem on nonplanar graphs. Frank Harary. February 1962. Unclassified.

A presentation of the argument that the use of Euler's polyhedron formula readily demonstrates the conjecture that for every graph G with $p \geq 11$ points, either G or its complementary graph \bar{G} is nonplanar. 6 pp. Illus.

P-2536. On the output probability density function of a linear device with certain nongaussian random inputs. G. M. Northrop. February 1962. Unclassified.

Treatment of the classical problem of determining the output probability density function (p.d.f.) of a zero-memory one-to-one nonlinear device followed by a linear filter. When the input random process is stationary, gaussian, and 1st-order Markoff, the output p.d.f. is shown to be the solution to a certain Fokker-Planck forward diffusion equation. 63 pp. Illus.

P-2538. A game theoretic approach to space vehicle prelaunch activities scheduling. S. I. Firstman. January 1962. Unclassified.

An application of game theory to the problem of maximizing the probability that each countdown of a launch vehicle culminates in a successful launch. The problem is formulated as a game against a malevolent chance. The paper demonstrates that a preferred sequence exists, and outlines the method of finding it. 25 pp. Illus.

P-2540. Some investment criteria for underdeveloped areas. H. A. Averch. February 1962. Unclassified.

A discussion of the social welfare function to determine the appropriate goal of an economy during the process of development. The social welfare functions used in development theory by Chenery, Eckstein, and Galenson-Leibenstein ignore individual preferences. This paper examines the social welfare functions used by these writers and the investment criteria derived from them. In general, they use aggregate production or income functions containing capital as the only argument, and the production functions are not derived from micro-economic postulates about the behavior of firms and consumers. 29 pp.

P-2541. On the optimality of sequential probability ratio tests. T. K. Matthes. February 1962. Unclassified.

A study concerned with the sequential probability ratio test for testing a simple hypothesis H_0 against a single alternative H_1 . This paper presents a proof of this optimality, which relies primarily on a simple mapping theorem. 6 pp.

P-2542. Notes on a conference with Soviet scientists. H. A. DeWeerd, A. L. Horelick, and N. C. Leites. February 1962. Unclassified.

An account of the Conference on Stability in a Demilitarized World, held at Santa Barbara, California, September 25 and 26, 1961. The supposed business of the meeting was to elicit from the Soviet participants their reactions to the question: Could the Soviet Union accept the kind of international order postulated by Walter Millis for the demilitarized world he described? This paper concerns itself primarily, however, with tentative hypotheses about Soviet conference behavior sug-

gested by incidents at this meeting and by the authors' previous studies and experiences. Maj. Gen. N. A. Talensky's opinion on stabilized deterrence is also summarized. 33 pp.

P-2543. A statistical approach to simulation. M. A. Geisler. February 1962. Unclassified.

An attempt to determine the statistical techniques that can be used in conjunction with simulation to help provide statistical confidence in the data developed by simulation models. First, the paper formulates some of the kinds of statistical questions that can be legitimately raised about simulation models. Then, it investigates the effect of the length of a simulation-model run on the precision with which certain stochastic variables in inventory problems can be estimated from data thus obtained. 23 pp.

P-2544. Mutual price discrimination in Soviet Bloc trade. Horst Mendershausen. March 1962. Unclassified.

An analysis of Soviet Bloc pricing practices showing the possible existence of multilateral and mutual discrimination among the Bloc countries. While the Soviet Union may offer less favorable trade terms to her satellites than to Free Europe, Bloc countries also offer less favorable trade terms to the Soviet Union and the other satellites than to Free Europe. In other words, the Soviet Union has created captive partners in a fenced-in area. Once political captives of the Soviet Union, the members are captives of each other in the net of economic dependencies as well. Together with the captor state, they appear to inflict on each other trade conditions that are disadvantageous by their own standards of fairness. 8 pp. See also RM-2507-1.

P-2545-1. The null set of the Euler-Lagrange operator. D. G. B. Edelen. April 1962. Unclassified.

A method whereby the space of Lagrangian functions can be reduced to the point where there is a one-to-one correspondence between such functions and the solution manifolds generated by them through the satisfaction of the Euler-Lagrange equations. This reduction is accomplished by use of the null set of the Euler-Lagrange operator. Explicit characterizations are defined for this null set so that the results may be used in a direct fashion. 17 pp.

P-2552. A one-day look at computing. G. W. Armerding, F. J. Gruenberger, S. L. Marks, and T. R. Parkin. March 1962. Unclassified.

An account of a visit by some high school students and their mathematics teachers to examine computers at RAND. Various events of the day are described: the lecture on the history of computing and the use of the desk calculator; the showing of the SDC film, "Computer Programming"; the introduction to flowchart notation and the logical organization of a single-address computer; the coding of two problems; and the debugging of a code written cooperatively by the group. As this experiment can be repeated by any group of computer people, several points are discussed to help in the preparation of such a project. 8 pp.

P-2554. The Soviet civil defense program. Leon Gouré. March 1962. Unclassified.

A description of the key features of the Soviet civil defense program and especially of those aspects that deal with defense against radioactive, chemical, and bacteriological agents. The reasons for the long-standing Soviet interest in civil defense are discussed, as well as the basic concepts of Soviet civil defense doctrine. Despite the fact that Soviet authorities appear to be losing interest in some types of urban shelters, and current Soviet propaganda is denying the value of civil defense, the author indicates that the Soviet Union still has an active civil defense program. 22 pp. Presented before the American Chemical Society at Washington, D.C., March 27, 1962.

P-2557. A data-processing system for state and local governments. E. F. R. Hearle. March 1962. Unclassified.

An approach to data systems for state and local governments that looks beyond mechanization of present procedures to the development of fresh concepts of information handling through the use of electronic data-processing (EDP) technology. The paper emphasizes the time period from 1970 to 1975 both as to foreseeable EDP equipment capabilities and as to trends in governmental characteristics that affect data systems. The entire complex of functions performed by states, counties, cities, townships, and districts is considered rather than the particular operations of any specific agency.

15 pp. Presented before the American Society for Public Administration National Conference at Detroit, Michigan, April 12, 1962.

P-2561. Some comparisons between the Russian and Chinese "models." D. S. Zagoria. March 1962. Unclassified.

An examination of some of the differences in the Russian and Chinese "roads to socialism," with particular emphasis on the relevance of one or the other "model" for other Asian countries. These differences can be traced to population-resource ratios, the manner in which the two parties acquired power, and the differing stages of socio-economic development in the two countries. Differences can also be traced to the fact that the Chinese could benefit from Soviet mistakes and from Soviet help, that the Soviets had the benefit of twenty or more years of regional power, and that in Russia the civil war occurred after and in China before the seizure of power. In the future communist world, each Asian state seeking to build socialism will probably be freer to experiment with indigenous forms and methods more in keeping with local problems. 39 pp. Presented before the Association for Asian Studies at Boston, Massachusetts, April 2-5, 1962.

P-2562. Britain's defense new look five years later. H. A. DeWeerd. March 1962. Unclassified.

Criticism of the British 1962 Defence White Paper in that it subordinates defense policy requirements to budget considerations, rather than to foreign policy needs. The progressive unfulfillment of British pledges to the defense of Western Europe is also deplored. For example, as a NATO country, England cannot count reserves at home as if they were in Europe. Her commitments to NATO are definite, yet her NATO forces are being reduced. The failure of the 1962 statement on defense is caused from the difficulty of formulating credible defense policies in a period of rapid technological and political change. Until Britain's entrance into the Common Market is completed and until basic questions of NATO strategy are settled, Britain can do little but mark time in the military sphere. 21 pp.

P-2563. Planned replacement. Milton Kamins. March 1962. Unclassified.

A study of replacement policies for aircraft and missile parts, showing how the appropriate replacement policy for any part depends on its failure characteristics and on the penalty associated with a failure in service. For planned replacement of a particular part to be worth while (i.e., replacement before failure), two necessary conditions must be satisfied. The part must display a wear-out characteristic (a failure rate that increases with time), and there must be some penalty for a failure in service (the cost of a failure in service must be greater than the cost of a planned replacement). The study discusses how an optimum planned replacement policy can be developed and presents empirical results for parts whose failure characteristics can be described by some of the better known probability distributions of mathematical statistics. It also shows the savings that can result from following such an optimal policy instead of a replace-at-failure-only policy. 23 pp. Illus. An abridgment of RM-2810-PR.

P-2565. Physicochemical characteristics of placental transfer. J. C. DeHaven, E. C. DeLand, N. S. Assali, and W. Manson. March 1962. Unclassified.

The construction of a biophysicochemical model of certain maternal-fetal circulatory and metabolic relations for an extra-uterine study of the transfer of respiratory gases and other elements across the placental membrane. The model is analyzed by a mathematical method for the minimization of a chemical free-energy function subject to constraints relating to mass, charge, and phase transfer. The model is then applied to the representation of the exchanges of respiratory gases occurring between the venous and arterial sides of the total air-blood system. The model indicates a greater acidity for the fetal than for the maternal erythrocyte intracellular medium. This feature, combined with other aspects of the results, may explain the lower oxygen saturation of fetal hemoglobin *in utero*, and also suggests that the fetal oxygen environment is not so inimical or stressful to the fetus as previously hypothesized. 24 pp. Illus.

P-2567. Economic-physical trade-offs in scheduling missile system checkouts. Milton Kamins. March 1962. Unclassified.

A discussion of some economic aspects of the use of test equipment, particularly automatic checkout equipment, in a system context. The paper attempts to develop a method for determining preferred inspection intervals, considering both readiness and costs, at a system level. The author shows how

readiness and costs are affected by the frequency of checkouts and how to achieve a desirable balance between them. Those systems are considered whose failures occur exponentially, or in a purely random fashion. 15 pp. Illus. See also RM-2750.

P-2568. Technological change and local economy. David Novick. March 1962. Unclassified.

A discussion of some of the technological changes that have already occurred as reflected in the national defense budget in an attempt to determine what these changes may mean to the economy and to forecast what must be done if future challenges are to be met successfully. The nuclear age has brought changes in system requirements that have resulted in shifts in the composition of labor-force demands, in facilities requirements, and in the make-up of the industry. These changes have forced reorganizations both in government and industry to improve the management of new programs. Still other changes will be necessary as space-age requirements are more clearly defined. 21 pp. Illus. Presented before the Economic Development Institute of Arizona at Tucson, Arizona, March 23, 1962.

P-2570. Sources of turbulence in the new nations. G. J. Pauker. March 1962. Unclassified.

An attempt to determine the sources of turbulence in new nations. One cause is largely attributable to the inherent contradictions between the goals that these nations try to achieve. Attention is given to the question of whether the means on which we rely to cope with these sources of turbulence are adequate. It is suggested that social science be given a chance to seek answers with the same detachment with which natural scientists are attempting to solve problems. The author feels that turbulence is likely to increase in the world as the process of modernization gains momentum. 11 pp. Presented before the Symposium on the U.S. Army's Limited-war Mission and Social Science Research at Arlington, Virginia, March 26-28, 1962.

P-2571. The Japanese Communists and their struggle for power. P. F. Langer. March 1962. Unclassified.

An analysis of the nature of the Japanese communist movement, which is one of the oldest communist organizations in Asia. Its troubled history and its slow rise to power, however, have prevented it from occupying a seat of honor among the world's communist parties. The context in which the Japanese Communists must operate is examined, as well as the ways in which they are attempting to meet the challenge. 41 pp. Presented before the Association for Asian Studies at Boston, Massachusetts, April 2-4, 1962.

P-2572. Design principles for an intelligent machine. M. E. Maron. March 1962. Unclassified.

A discussion of the role of prediction as the key process underlying the function of an intelligent machine. A model of a "neuron" is presented that exhibits properties of memory and learning. The formalism of the calculus of probability allows an interpretation of the behavior of a neuron in such a way as to justify how a network of such elements can be organized so that it can learn to predict. 25 pp. Illus. To be presented before the International Symposium on Information Theory at Brussels, Belgium, September 3-7, 1962.

P-2574. Problems of support planning. W. A. Steger. April 1962. Unclassified.

An attempt to assist the operations researcher make his work more helpful for the support planner by discussing the problem areas that reduce the effectiveness of interaction between the two groups. The support planner should be more explicit about the lead times required to make major decisions and about reappraising his findings in the light of unfolding data. The operations researcher must find better ways to adapt his techniques to the uncertainties, complexities, and adaptive nature of the support planner's decision processes. 13 pp. Illus. Presented before the Military Operations Research Symposium at Newport News, Virginia, April 24-26, 1962.

TRANSLATIONS

- **RAT-1. Optimum shapes for axially symmetrical supersonic thrust nozzles.** G. Guderley and E. Hantsch. Trans. by K. G. Liebhold. 9-4-47. Unclassified.
The calculus of variation applied to the determination of the supersonic section of thrust nozzles which produce maximum thrust at given mass rate of flow, length, and exit cross section. 37 pp. Illus.
- **RAT-2. Collection of some German data on special type landing gears.** Woyzechowski. Trans. by K. G. Liebhold. 8-1-47. Unclassified.
A discussion of the means by which overloaded airplanes may take off. Several problems considered are (1) the auxiliary rolling and jettisonable gears and (2) launching large-size, overloaded airplanes by a catapult or an electrically driven take-off cart. 25 pp. Illus.
- **RAT-3. Discussions on high-speed aerodynamics.** 10-8-47. Unclassified.
A report on an interview with Dr. B. Gothert, a German specialist in high-speed aerodynamics, to determine the German developments in this field. 80 pp.
- **RAT-4. Monograph on the theory of characteristics.** G. Guderley. Trans. by K. G. Liebhold. 9-1-47. Unclassified.
The theory of characteristics is derived for two-dimensional and axially symmetrical supersonic flow. Analyses of nonsteady and conical flows are included. 226 pp. Illus.
- **RAT-5. Equipment used to determine the effect of sound and oscillations on the human body.** R. Coermann. Trans. by K. G. Liebhold. 11-3-47. Unclassified.
A description of test equipment by which vibrations with a frequency range from 30 to 1000 c/sec and with amplitudes up to 2 mm can be transmitted to a human body. An analysis of the different oscillators and their mode of operation. 20 pp. Illus.
- **RAT-6. The laminar boundary layer on a cone in a supersonic air stream at zero angle of attack.** W. Hantzsche and H. Wendt. Trans. by K. G. Liebhold. 11-13-47. Unclassified.
The process of integrating the equations for the laminar boundary layer on a cone which is reduced to a simple two-dimensional case. 7 pp. Illus.
- **RAT-7. Approximation of empirical functions of discrete distribution by discontinuous orthogonal polynomials.** Vettin. Trans. by K. G. Liebhold. 11-26-47. Unclassified.
A description of a method of approximation in which the Gaussian normal equations are eliminated by orthogonalization of suitable polynomials in the sense of the calculus of finite differences. 19 pp.
- **RAT-8. Cones in supersonic flow.** W. Hantzsche and H. Wendt. Trans. by K. G. Liebhold. 1-5-48. Unclassified.
An elementary review of the conical field theory, followed by an exact analysis of supersonic flows over cones for Mach numbers ranging from zero to infinity and for all cone angles. 36 pp. Illus.
- **RAT-9. Increase in sensitivity of amplifiers and mixers in the meter and decimeter wave range.** M. J. O. Strutt. Trans. by K. G. Liebhold. 3-10-48. Unclassified.
A derivation of maximum increase in output of amplifiers and mixers in decimeter wave equipment for narrow and wide frequency bands. The development of the theory to determine the noise factors. A discussion of the reduction of noise factors or their total elimination by a suitable feedback circuit. 26 pp. Illus.
- **RAT-11. Number of rounds required and destruction probability in form of tables and graphs.** Herbert Langner. Trans. by K. G. Liebhold. 4-6-48. Unclassified.
A tabular and graphical interrelation of four quantities. Those discussed are (1) the number of rounds required, (2) the single-hit probability, (3) the number k of hits necessary to destroy the target using the specified type of ammunition, and (4) the destruction or success probability. 61 pp. Illus.

- **RAT-12. The effect of compressibility on the laminar boundary layer of a flat plate.** W. Hantzsche and H. Wendt. Trans. by K. G. Liebhold. 5-14-48. Unclassified.
A study of the laminar boundary layer of a flat plate. The report shows that flow equations can be satisfied if the heat content is assumed to be a function of the velocity component parallel to the plate. 17 pp. Illus.
- RAT-13. Propagation of long waves around the earth.** O. Zinke. Trans. by K. G. Liebhold. 9-15-48. Unclassified.
A report on long radio wave propagation around the earth. In comparison with the known Austinian formula, the new field strength formula differs in (1) the functional relationship with distance, (2) the effect of wave length of the damping factor, and (3) the effect of noise at the antipole of the transmitter. 27 pp. Illus.
- T-14. Collection of articles on the theory of firing.** A. N. Kolmogorov (ed.). Trans. by Edwin Hewitt. 10-13-48. Unclassified.
A presentation of the theory of firing and the mathematical methods of solving the complicated problems which depend on obtaining precise expressions for the different firing probabilities, such as the number of hits in a number of shots and the use of artificial dispersion. 132 pp. Illus.
- **T-15. Some problems of flow, heat transfer, and diffusion in the laminar flow along a flat plate.** H. Schuh. Trans. by K. G. Liebhold. 2-20-49. Unclassified.
A presentation of a theory which utilizes the Polhausen solution for the laminar temperature field at the flat plate in longitudinal flow. These formulas calculate the velocity and temperature fields for variable properties by an integral equation, and an iteration method based on this equation is given. 22 pp. Illus.
- **T-16. Some questions of aerodynamic damping and dynamic stability.** W. Heybey. Trans. by K. G. Liebhold. 3-23-49. Unclassified.
A study of damping based on experimental data as a significant factor in missile stability. A summarization of (1) the similarity theorem for damping and (2) dynamic stability. 13 pp. Illus.
- **T-17. The possible spread of radioactive infection by the fission products of U²³⁵.** Hans Thirring. Trans. by K. G. Liebhold. 9-23-49. Unclassified.
A translation of an Austrian article on the order of magnitude of the extent of radioactive contamination. Materials for contamination purposes are enumerated and their effectiveness by gamma and beta radiation is analyzed. 22 pp. Tables.
- **T-18. Excerpt from "Motion of compressible and incompressible fluids."** Adolf Busemann. Trans. by K. G. Liebhold. 12-12-49. Unclassified.
An excerpt of the Busemann article on gas dynamics. His theory is compared to the Newtonian theory, with emphasis on centrifugal forces. The lift and drag of an airfoil in compressible and incompressible flow are also studied. 5 pp.
- **T-19. Elementary theory of convex polyhedrons.** Von H. Weyl. Trans. by R. W. Shephard. 4-17-50. Unclassified.
An exposition and proof of the fundamental theorem on convex polyhedrons with its applications to systems of linear homogeneous inequalities. 26 pp.
- **T-20. Summary of the status of German antiaircraft in the final phase of World War II.** Otto Svoboda. Trans. by K. G. Liebhold. 8-25-50. Unclassified.
A summary of the number of people employed in German flak organizations and of the number of types of armament pieces. 3 pp.
- **T-21. On the spin and the structure of electrons.** F. Bopp. Trans. by K. G. Liebhold and N. C. McMillan. January 1951. Unclassified.
A quantitative analysis of the HönI theory of pole-dipole particles on the basis of the field theory which is used without referring to new auxiliary hypotheses. His theory is contrasted with the Goudsmit-Uhlenbeck theory. 12 pp.

- **T-22. The theory of linear inequalities.** Theodor Motzkin. Trans. by D. R. Fulkerson. 3-7-52. Unclassified.
A discussion of the problem of determining all those linear transformations which never increase the number of sign changes in the sign rule of Descartes and its generalizations. 86 pp. Illus.
- **T-24. The perturbation of pendulum and gyroscope instruments by acceleration of the vehicle.** M. Schuler. Trans. by W. E. Frye. 6-16-52. Unclassified.
A report which (1) discusses briefly the effect of accelerations of a vehicle on pendulum and gyro equipments and (2) shows how such disturbances can be avoided. 14 pp. Illus.
- **T-25. Undetermined wage problems.** F. Zeuthen. Trans. by Olaf Helmer. 10-31-52. Unclassified.
An attempt to determine a rational price policy under such conditions as (1) both the entrepreneur and worker are completely organized, (2) the amount of wages has no effect upon employment volume, and (3) the settlement occurs solely on the basis of a fight or threat of a fight. 37 pp. Illus.
- **T-27. A summary of known distribution functions.** B. Haller. Trans. by R. E. Kalaba. 1-7-53. Unclassified.
A tabular summary of distribution functions and their characteristic functions which had become significant by 1941. In addition, applications of these functions are indicated, and references to the literature are given. 29 pp. Illus.
- **T-28. Russian tactics.** Trans. by J. J. O'Sullivan. 7-24-53. Unclassified.
Minutes of the Russian Theoretical Conference on Tactics of Kuks "Wystrel," 1942. The principles employed by the USSR in attacking normal German defenses are discussed with particular reference to the Russian breakthrough strategy which divided, encircled, and destroyed the enemy. 23 pp. Tables.
- **T-29. When can the Soviet Union risk atomic war?** Trans. by E. W. Schnitzer. 2-26-54. Unclassified.
A translation of an article in the February, 1954, issue of *Flugwelt*, a West German aviation monthly. Soviet atomic centers are named, and Russian preparations for atomic war are reviewed. 6 pp.
- **T-32. The brush-off is called "new look."** Klaus Mehnert. Trans. by T. I. Edwards. 4-13-54. Unclassified.
A translation of an editorial in the March 18, 1954, issue of *Christ und Welt*. U.S. reliance on strong retaliatory power is discussed, together with the dangers of this strategy and its effect on Europe. 5 pp.
- **T-33. The secret weapons of the Soviet Union.** Volursus. Trans. by E. W. Schnitzer. February 1954. Unclassified.
A translation of an article in the November, 1953, issue of the West German magazine, *Flugwelt*. USSR rocket and guided missile preparations are examined, and new Soviet launching sites are described. 8 pp.
- **T-34. Shock waves in isotropic elastic media.** Trans. by J. D. Cole. 5-5-54. Unclassified.
An abstract from a report to the Convention on Thermodynamics (held in Saint-Louis, France, October, 29-30, 1951). Plane shock waves are examined which penetrate an isotropic unstressed material and produce a stress. 17 pp.
- **T-35-Part I. Red Star series on atomic energy—part I: structure and properties of the nucleus.** V. Mikhailov. Trans. by F. J. Krieger. 1-14-54. Unclassified.
A translation of an article in the January 14, 1954, issue of *Red Star*, the USSR Ministry of Defense organ. The contributions Soviet science has made to the production and utilization of atomic energy for peaceful purposes are described. 10 pp.
- **T-35-Part II. Red Star series on atomic energy—part II: radioactive disintegration of nuclei.** V. Mikhailov. Trans. by F. J. Krieger. 2-26-54. Unclassified.
A discussion of the Soviet contribution to the development of the materialistic doctrine concerning atoms. This article appeared in the February 26, 1954, issue of *Red Star*. 10 pp. Illus.

- **T-35—Part III. *Red Star* series on atomic energy—part III: nuclear reactions.** M. Mkrtychev. Trans by F. J. Krieger. 3-4-54. Unclassified.
An investigation of radioactive transformations in order to determine how they are achieved and controlled. This translation appeared in the March 4, 1954, issue of *Red Star*. 10 pp.
- **T-35—Part IV. *Red Star* series on atomic energy—part IV: the physics of a nuclear explosion.** M. Arkhipov. Trans. by F. J. Krieger. 3-20-54. Unclassified.
An examination of various aspects of the atomic explosion, as discussed in the March 20, 1945, issue of *Red Star*. 11 pp.
- **T-35—Part V. *Red Star* series on atomic energy—part V: the thermonuclear reaction with hydrogen.** M. Arkhipov. Trans. by F. J. Krieger. 3-26-54. Unclassified.
An article from the March 26, 1954, issue of *Red Star*. The principle of constructing the hydrogen bomb and other hydrogen weapons, based on the use of the thermonuclear reaction with hydrogen, is discussed. 10 pp.
- **T-35—Part VI. *Red Star* series on atomic energy—part VI: atomic energy in the service of the national economy.** V. Mikhailov and M. Mkrtychev. Trans. by F. J. Krieger. 4-7-54. Unclassified.
An article on the industrial uses of atomic energy in the USSR, as reported in the April 7, 1954, issue of *Red Star*. 10 pp. Illus.
- **T-35—Part VII. *Red Star* series on atomic energy—part VII: the physics of the behavior of nuclear forces—the shock wave.** G. Pokrovsky. Trans. by F. J. Krieger. 5-6-54. Unclassified.
An article from the *Red Star* series which investigates the shock wave of an atomic and hydrogen explosion. 11 pp. Illus.
- **T-35—Part VIII. *Red Star* series on atomic energy—part VIII: the physics of the behavior of nuclear forces—light radiation.** M. Arkhipov. Trans. by F. J. Krieger. 5-8-54. Unclassified.
An article, from the May 8, 1954, issue of *Red Star*, which discusses light radiation (the energy released by chain reactions of the explosive type). 10 pp. Illus.
- **T-35—Part IX. *Red Star* series on atomic energy—part IX: the physics of the behavior of nuclear forces—penetrating radiation.** A. Sedov. Trans. by F. J. Krieger. 5-13-54. Unclassified.
An article from the May 13, 1954, issue of *Red Star*, which discusses the properties and effects of penetrating radiation from an atomic explosion. 10 pp. Illus.
- **T-35—Part X. *Red Star* series on atomic energy—part X: the physics of the behavior of nuclear forces—radioactive substances.** A. Sedov. Trans. by F. J. Krieger. 5-20-54. Unclassified.
Data on the discovery, characteristics, application, and effects of radioactive substances. This article appeared in the May 20, 1954, issue of *Red Star*. 9 pp.
- **T-35—Part XI. *Red Star* series on atomic energy—part XI: the physics of the behavior of nuclear forces in the atmosphere and at sea.** G. Pokrovsky and M. Arkhipov. Trans. by F. J. Krieger. 6-4-54. Unclassified.
A discussion of the properties of an atomic explosion in the atmosphere, above the sea and land, and under water. This study shows how the medium in which an atomic explosion occurs influences the shock wave, its radiations, and radioactive contaminations. 10 pp.
- **T-35—Part XII. *Red Star* series on atomic energy—part XII: the physics of the behavior of nuclear forces—radiation measurements.** V. Sirnev. Trans. by F. J. Krieger. 6-10-54. Unclassified.
Another article in the *Red Star* series which discusses radiometric and dosimetric instruments, used for detecting and measuring the radiation of radioactive substances. 9 pp. Illus.

- **T-36. Chats on the atomic weapon.** Trans. by F. J. Krieger. 7-3-54. Unclassified.

An article on the conduct of troops under atomic warfare conditions, as translated from the July 3, 1954, issue of *Red Star*. 3 pp.

- **T-37. On the new American submarine *Nautilus*.** T. Belashchenko. Trans. by F. J. Krieger. 6-19-54. Unclassified.

A propagandistic attempt to belittle the first atomic submarine, the *Nautilus*. This article appeared in the June 19, 1954, issue of *Red Star*. 13 pp.

- **T-38. Problems of interplanetary flights.** K. Stanyukovich. Trans. by F. J. Krieger. 11-15-54. Unclassified.

A translation of a paper which appeared in the August 10, 1954, issue of *Red Star*. The contributions of Soviet scientists in solving interplanetary flight problems are discussed. 9 pp.

- **T-39. Diffusion of meteoric trails.** O. V. Dobrovol'skii. Trans. by A. E. Nimitz. 11-22-54. Unclassified.

A translation of an article on the diffusion of a meteoric trail, defined as a band of ionized gas which is luminescent as a result of recombination processes. This study considers (1) the case of a meteoric trail with a small ionic density where the loss of ions due to burning out is ignored and (2) the generalized case which includes a correction for the burning out of the ionic cloud. 23 pp. Illus.

- **T-40. Soviet long-range bomber bases near the North Pole.** Volursus. Trans. by E. W. Schnitzer. 12-28-54. Unclassified.

A discussion of various Soviet preparations in the Arctic region which deal with the staging of bases and troops, their long-range bombers and special fuel reserves. This article was translated from the November, 1954, issue of the West German aviation monthly, *Flugwelt*. 9 pp.

- **T-41-Part I. *Red Star* series on atomic weapons and antiatomic defense.** B. Olisov. Trans. by F. J. Krieger. 8-3-54. Unclassified.

An examination of the characteristics and effects of various atomic weapons. The translations in this *Red Star* series are considered militarily important as they were broadcast to the Soviet Armed Forces in the Far East. 10 pp.

- **T-41-Part II. *Red Star* series on atomic weapons and antiatomic defense.** B. Olisov. Trans. by F. J. Krieger. 8-4-54. Unclassified.

A discussion of the present state of Soviet antiatomic defense for protecting her troops against atomic weapons. In particular, the effect of the shock wave is considered. 9 pp. Illus.

- **T-41-Part III. *Red Star* series on atomic weapons and antiatomic defense.** B. Olisov. Trans. by F. J. Krieger. 8-6-54. Unclassified.

An investigation of the physical basis of damaging factors of an atomic explosion other than its shock wave and radiation. In addition, measures for averting the destructive effects of such a blast on personnel and military equipment are discussed. 9 pp. Illus.

- **T-41-Part IV. *Red Star* series on atomic weapons and antiatomic defense.** A. Glushko. Trans. by F. J. Krieger. 8-25-54. Unclassified.

A Russian study of ways to use the protective properties of the terrain (e.g., the relief, woods, buildings, and other local objects) in order to promote the conduct of active combat operations during atomic attack. 9 pp.

- **T-41-Part V. *Red Star* series on atomic weapons and antiatomic defense.** A. Glushko. Trans. by F. J. Krieger. 8-26-54. Unclassified.

A translation of a Russian article dealing with the engineering preparation of the terrain during atomic attack (e.g., earthen shelters for both men and materiel) as an aid in successfully executing Soviet combat missions. 9 pp.

- **T-41—Part VI. *Red Star* series on atomic weapons and antiatomic defense.** A. Glushko. Trans. by F. J. Krieger. 8-28-54. Unclassified.
A study of specific methods (used to de-activate radioactively contaminated terrain) for reducing the damaging effect of the products of radioactive decay on man and to increase the combat activity of Soviet troops. 9 pp. Illus.
- **T-42—Part I. *Red Star* series on the problems of utilizing atomic energy—part I: on the way to controlled nuclear reactions.** V. Mikhailov. Trans. by F. J. Krieger. 8-31-54. Unclassified.
The first in a series of Russian articles concerning the use of atomic energy. The present translation discusses how the USSR is overcoming the difficulties of mastering the controlled thermonuclear reaction. 10 pp.
- **T-42—Part II. *Red Star* series on the problems of utilizing atomic energy—part II: sources of nuclear fuel.** A. Sedov. Trans. by F. J. Krieger. 9-2-54. Unclassified.
A discussion of the Soviet problem of obtaining a sufficient quantity of nuclear fuels so that atomic energy may be successfully applied to develop productive forces. Uranium, thorium, and hydrogen are the sources of nuclear fuel considered. 9 pp.
- **T-42—Part III. *Red Star* series on the problems of utilizing atomic energy—part III: nuclear reactors.** M. Arkhipov. Trans. by F. J. Krieger. 9-7-54. Unclassified.
A study of the problems connected with the construction, operation, and application of heterogeneous and homogeneous nuclear reactors. 9 pp.
- **T-42—Part IV. *Red Star* series on the problems of utilizing atomic energy—part IV: the nuclear power station.** I. Naumenko. Trans. by F. J. Krieger. 9-11-54. Unclassified.
A Russian discussion of a nuclear power station, its advantages and disadvantages as compared with conventional thermal power stations, and several methods for transforming atomic energy directly into electrical energy. 10 pp. Illus.
- **T-42—Part V. *Red Star* series on the problems of utilizing atomic energy—part V: the nuclear fuel engine.** G. Pokrovsky. Trans. by F. J. Krieger. 9-15-54. Unclassified.
A discussion of the application of atomic engines to submarines, aircraft, guided missiles, and automobiles. 9 pp.
- **T-42—Part VI. *Red Star* series on the problems of utilizing atomic energy—part VI: the atomic industry—1.** A. Komanov. Trans. by F. J. Krieger. 1-11-55. Unclassified.
A Soviet study of the uranium ore processing plants in Belgium, Canada, England, and the United States. This translation lists their geographical location and discusses the military character of the U.S. atomic industry. 9 pp.
- **T-42—Part VII. *Red Star* series on the problems of utilizing atomic energy—part VII: the atomic industry—2.** P. Astashenkov. Trans. by F. J. Krieger. 1-19-55. Unclassified.
A study of the atomic industry in Britain. This Russian translation is based on *Britain's Atomic Factories, The Story of Atomic Energy Production in Britain* by K. E. B. Jay. 9 pp.
- **T-42—Part VIII. *Red Star* series on the problems of utilizing atomic energy—part VIII: the use of radioactive substances in technology.** A. Nesmeyanov. Trans. by F. J. Krieger. 3-13-55. Unclassified.
A Russian discussion of the use of radioactive substances in the radioscopic examination of metallic articles for defects and in other industrial and laboratory processes. 9 pp.

- T-42—Part IX. *Red Star* series on the problems of utilizing atomic energy—part IX: nuclear radiations and medicine. D. Ivanov. Trans. by F. J. Krieger. 4-5-55. Unclassified.

A Soviet article which considers the methods, used in Russian medical practice, of investigating and treating various diseases. Radiations emitted by naturally and artificially radioactive substances are applied. 9 pp.

- T-43. Two German news items on atomic developments in the Soviet Union. Trans. by E. W. Schnitzer. 4-22-55. Unclassified.

A translation from the February, 1955, issue of *Wehrtechnische Hefte*, a West German military journal. An atomic industry project at Angara, Siberia, is discussed, together with USSR uranium deposits. 7 pp.

- T-44. *Red Star* series on guided missiles—part I: construction and methods of application. V. Pugachev and B. Marisov. Trans. by F. J. Krieger. 2-15-55. Unclassified.

The first in a series of Russian articles concerning guided missiles. Their methods of guidance and of application are considered. 9 pp. Illus.

- T-45. On a problem of the comparison of two empirical distributions. B. V. Gnedenko and E. L. Rvachëva. Trans. by H. P. Edmundson. 6-2-55. Unclassified.

A Russian article concerning the problem of the divergence of empirical distribution functions. 7 pp.

- T-46. *Red Star* on refueling aircraft in the air. Y. Rusyantsev. Trans. by F. J. Krieger. 7-5-55. Unclassified.

A Soviet article concerning aerial refueling of aircraft. Part I discusses the advantages resulting from single and multiple inflight refueling of high-speed bombers and fighters. Part II describes two methods of aerial refueling and related problems. 8 pp. Illus.

- T-47. The influence of weak atmospheric inhomogeneities upon the propagation of sound and light. A. M. Obukhov. Trans. by W. C. Hoffman. 7-28-55. Unclassified.

A translation of a Russian article concerning wave propagation in a medium with fluctuating refractive index. This problem, related to the theory of twinkling stars and atmospheric acoustics, is reduced to linearized equations satisfied by the phase and logarithmic amplitude of the propagating wave. 20 pp.

- T-48. On the Cauchy problem for nonlinear equations in a class of discontinuous functions. O. A. Oleinik. Trans. by R. E. Kalaba. 7-27-55. Unclassified.

A translation of a Russian paper concerning the solution of the Cauchy problem in which countably many discontinuities are permitted in the initial data. 11 pp.

- T-49. On waves of loading and unloading, arising from the motion of an elastic or plastic flexible fibre. N. Cristescu. Trans. by J. H. Huth. 8-23-55. Unclassified.

A Russian translation applicable to studies concerning aircraft arresting gear and barrage balloon cables. The general theory of waves in elastic-plastic fibres is described, together with the case of an ideally plastic fibre of a linear approximation. 21 pp. Illus.

- T-50. Soviet schools in science: translation of and comments on a Russian *Literary Gazette* article. A. I. Knunyants and L. Zubkov. Trans. by F. J. Krieger and V. S. Jittlov. 9-12-55. Unclassified.

A translation of and comments on a Russian article (appearing in the January 11, 1955, issue of *Literaturnaya Gazeta*) which advocates the need for greater freedom in Soviet scientific research and for open competition among rival schools of scientific thought. 17 pp.

T-51. On the spectrum of singular boundary-value problems for elliptic differential equations. M. Birman. Trans. by M. L. Juncosa. 10-5-55. Unclassified.

A translation of a Russian article concerning the spectrum of singular boundary-value problems for elliptic differential equations. 7 pp.

T-52. The motion of a satellite station around the earth in an elliptical orbit inclined to the earth's equator. H. Krause. Trans. by R. E. Vernon. 10-21-55. Unclassified.

A translation of two German articles from *Weltraumfahrt*, Nos. 1 and 3 (1952). The fundamental equations for calculating an elliptical orbit inclined to the earth's equator are presented in order to investigate the physical-technical conditions necessary to construct a satellite station. 26 pp. Table.

T-53. On the problem of cooling atomic rockets which utilize thermonuclear reactions. H. J. Kaeppler. Trans. by R. L. Bjork. 1-11-55. Unclassified.

A proof that a suitable modification of Oberth's *Schleierkühlung* (screen cooling) is adequate at extremely high temperatures such as appear in atomic jet engines. This German translation considers a cooling method for permitting very high temperatures at the reactor's center, the motion of the medium in the rocket chamber as well as the heating and heat conductivity problem, and a formulation of the complete heat conductivity coefficient, including energy transfer due to radiation. 40 pp. Illus.

T-54. Possibilities of transition from an elliptical orbit to a circular orbit, and vice versa. W. Schaub. Trans. by R. E. Vernon. 11-15-55. Unclassified.

A translation of two German articles from *Weltraumfahrt*, Nos. 3 and 4 (1952). A theoretical procedure is discussed which consists of influencing constantly the radial and transverse components of the velocity in space of a freely gravitating object. This is accomplished by a steering apparatus so that the object follows the parabolic envelope of ellipses of equal total energy with a given velocity. 24 pp. Illus.

T-55. The Russian atomic airplane of the future. G. I. Pokrovsky. Trans. by F. J. Krieger. 1-26-56. Unclassified.

A translation of a Russian article published in the August, 1955, issue of *Technology for Youth*. Solutions to various problems concerned with atomic airplanes are considered. 7 pp. Illus.

T-56. The fluid half space under a mechanical influence on its surface (two-dimensional problem). F. Sauter. Trans. by H. A. Lang. 1-31-56. Unclassified.

A translation of a German article published in the May-June, 1950, issue of *ZAMM*. The propagation of waves in acoustic approximation and in a liquid semi-infinite body is analyzed. It is assumed that the pressure acting on the liquid's surface depends on the time and on one of the Cartesian coordinates in the surface. A velocity potential is given as a double integral of the pressure on the surface multiplied by a certain Green's function. 12 pp. Illus. See also T-59.

T-57. On certain unsteady motions of a compressible fluid. L. I. Sedov. Trans. by F. J. Krieger. 2-3-56. Unclassified.

A translation of a Russian article which discusses various exact solutions of the equations for one-dimensional unsteady motion of a compressible fluid in the case of plane waves and motions with cylindrical and spherical symmetry. 36 pp. Illus.

T-58. Steady nuclear combustion in rockets. E. Säger. Trans. by R. D. Holbrook. 12-1-55. Unclassified.

A translation of a German paper presented before the Fifth Astronautical Congress at Innsbruck, Austria, August 5, 1954. The astrophysical theories of stationary nuclear reactions in stars are applied to cases of technically controlled nuclear fires. These are distinguished from the former by the smaller available combustion pressures, reactant volumes, and burn-up times. 54 pp. Illus.

T-59. The elastic half space under a mechanical disturbance of its surface (two-dimensional problem). F. Sauter. Trans. by H. A. Lang. 2-17-56. Unclassified.

A continuation of T-56, a German translation. The two-dimensional propagation of waves is investigated for the case where the medium is an elastic semi-infinite body bounded by a plane surface under an arbitrary (one-dimensional) strain. 23 pp. Illus.

T-60. The theory of mixture preparation in continuously burning combustion chambers (parts I and II). E. Sanger. Trans. by M. Goldsmith. 5-22-56. Unclassified.

A German translation of an article from the January and February, 1951, issues of *Brennstoff-Chemie*. This investigation deals with the injection and separation of liquid fuels in continuously burning combustion chambers with emphasis on steady-state reaction motors. Methods are discussed for achieving the smallest possible combustion chamber and the fastest possible separation. 94 pp. Illus.

T-62. Results of experiments in organizing the stepwise scheduled routes on the RR line Korosten-Odessa: by Dul'nyev, Furman, Baranov, and Sin'yov. Trans. by V. S. Jittlov. 6-21-56. Unclassified.

Excerpts from a Russian book published by the Ukrainian Academy of Sciences, Kiev, 1936. Reasons are given for the Technical Council of the Central Operation Management of Railroads recognizing the expediency of the stepwise marshalling system for Soviet railroads. 10 pp.

T-63. The scattering of light in planetary atmospheres. V. A. Ambartsumian. Trans. by R. E. Kalaba. 6-21-56. Unclassified.

A translation from the Russian book, *Theoretical Astrophysics*. Ambartsumian's "principle of invariance" for problems of multiple scattering is discussed, together with some of its simplest consequences. 28 pp. Table. See also P-839, P-976, P-996, P-1102, P-252, P-1380, P-1390, and P-1495.

T-64. On amplitude and phase pulsations of a wave propagating in a slightly inhomogeneous atmosphere. V. I. Tatarskii. Trans. by R. E. Kalaba. 6-19-56. Unclassified.

A translation of a Russian article which appeared in a recent issue of *Doklady Akad. Nauk SSSR*. Obukhov's approach to certain problems involving wave propagation through media with small, random inhomogeneities is modified. 9 pp.

T-65. A tank duel with game-theoretic implications. L. E. Zachrisson. Trans. by J. J. Robbins. 7-17-56. Unclassified.

A translation of a Swedish article from a 1955 issue of *Artilleri Tidskrift*. A model is given for a duel between two tanks, and the associated game-theoretic problem is solved. It is shown that the model may be generalized to a high degree and that other weapon characteristics and battle situations may be evaluated by this method. 16 pp. Illus.

T-66. Asymptotic expansions for the distribution of maximum deviations in the Bernoulli scheme. V. S. Korolyuk. Trans. by H. P. Edmundson. 9-7-56. Unclassified.

A translation of a Russian article which presents a method of construction of asymptotic expansions for the distribution functions of maximum deviations of sums of independent random variables. This method can be applied to more general schemes, such as the case of lattice random variables and random variables having a density function. 6 pp.

T-67. On a local limit theorem for inhomogeneous Markov chains. V. A. Statulyavichus. Trans. by H. P. Edmundson. 8-25-56. Unclassified.

A translation of a Russian article published in *Dokl. Akad. Nauk SSSR*, Vol. 107, No. 4, 1956. A proof is presented of two local limit theorems that are analogous to results obtained by A. N. Kolmogorov for homogeneous Markov chains and by Yu. V. Linnik for inhomogeneous chains of Doeblin type A. 7 pp.

T-69. The attainability of the stars (*Die Erreichbarkeit der Fixsterne*). Eugen Sänger.
Trans. by R. Schamberg. 12-26-56. Unclassified.

A translation of a speech presented before the Seventh International Astronautical Congress at Rome, Italy, in September, 1956. The laws of relativistic mechanics are applied to the hypothetical problem of interstellar space flight. It is stated that, by recourse to the phenomenon of time dilation, flights of any conceivable magnitude can be accomplished within the eigenlifetime of the flight-vehicle crews. 27 pp. Illus.

T-71. On some identically distributed statistics. Y. V. Linnik. Trans. by D. S. Stoller.
2-1-57. Unclassified.

A translation of a Russian article from a 1953 issue of *Doklady Akademii Nauk SSSR*. It is assumed that x_1, x_2, \dots, x_n are independent random variables with a common distribution and that x_1 and x_2 are two continuous functions of the x_i which differ in certain specified ways but which have the same distribution. These conditions restrict F , and it is shown, under further conditions imposed by the author, that F must have certain particular forms. 5 pp.

T-72. Excerpt from *Construction of aircraft (konstrukcii samoletov)* dealing with the evolution and uses of Soviet airplanes. M. N. Shul'zhenko. Trans. by
D. F. Baer and V. S. Jittlov. 6-19-57. Unclassified.

An excerpt from M. N. Shul'zhenko's *Construction of Aircraft (Konstrukcii Samoletov)* concerned with the evolution and uses of Soviet airplanes. This book is intended as a guide for new cadres of Soviet aviation designers. 22 pp. Illus.

T-73. Some new Soviet material on missiles. H. S. Dinerstein. 6-20-57. Unclassified.
Excerpts from *Science and Technology in Modern Wars* by Major General G. I. Pokrovskii. This book discusses the expected accuracy of long-range ballistic missiles, their strategic importance, and the ease with which they may be detected. The excerpts are presented, without analysis, prior to the appearance of a full-length analytic study on Soviet strategic thinking. 26 pp.

T-74. On the problem of a streamlined profile in a near-sonic flow. A. F. Kryuchin.
Trans. by V. S. Jittlov and J. L. Raymond. 8-15-57. Unclassified.

A translation of a Russian article on a steady near-sonic flow of gas in the absence of friction and heat transfer. A streamlined wedge of small included angle with a detached shock wave is studied in a stream the velocity of which slightly exceeds the velocity of sound at infinity. The distribution of pressure over the profile, the location and shape of the shock wave, and the equations of the sonic line are determined. 25 pp. Illus.

T-75. An asymptotic expansion for inhomogeneous Markov chains. V. A. Statulyavichus. Trans. by H. P. Edmundson. 9-9-57. Unclassified.

A translation of a paper by V. A. Statulyavichus, presented to the Academy of Sciences of the USSR by A. N. Kolmogorov in August, 1956. An inhomogeneous Markov chain with a finite number $s > 1$ of possible states e_1, \dots, e_s and transition probabilities $p_{\alpha\beta}^{(k)}$ from state e_α on the $(k-1)$ -th step to state e_β on the k th step is studied. 3 pp.

T-76. *The causes of systematic error in the cost estimates of public works* by R. Giguet and G. Morlat (Paris, 1952). Trans. by W. W. Taylor. 9-27-57. Rev. 3-24-58.
Unclassified.

An attempt to explain why construction costs are consistently underestimated. Two main reasons are adduced: (1) The probability density function of cost estimates is not symmetric, and the estimates tend to be based on the model rather than the mean value. (2) Since the choice among projects to be constructed is determined in part by their estimated costs, there results a bias toward choosing those projects whose costs have been underestimated and against those whose costs have been overestimated. 29 pp. Illus.

T-77. Two Russian articles on the ballistic missile. Trans. by H. S. Dinerstein. 10-15-57.
Unclassified.

Translations of two Russian articles: "How the Guidance of the Intercontinental Ballistic Missile Is Carried Out: An Interview with Doctor of Technical Sciences, Comrade I. E. Kazakov"

(*Sovetskaia Aviatsiia*, August 31, 1957), and "The Development of Rocket Technology," by Major General V. A. Semenov (*Sovetskaia Rossiia*, September 14, 1957). A figure is given for the maximum error (not CEP) from the target of ballistic missiles, an example is described of a possible guidance system for ballistic missiles, and it is stated that one of the satellites to be launched during the geophysical year will weigh several kilograms. 11 pp.

T-78. The artificial satellite and international law. G. Zadorozhnyi. Trans. by A. M. Jonas. 11-12-57. Unclassified.

A translation of and commentary on a Russian article concerned with the legal status of outer space, which was published in the October 17, 1957, issue of *Sovetskaia Rossiia*. Zadorozhnyi takes the position that freedom of outer space is analogous to freedom of the seas (i.e., the upper atmosphere, which is beyond the limits of effective air control by states, can be considered a zone of open air, in general use by all nations). 9 pp.

T-79. The role of science and technology in modern war. Maj. Gen. G. I. Pokrovskii. Trans. by H. S. Dinerstein. 2-5-58. Unclassified.

A translation of a Russian article, published in 1957 as part of a series of pamphlets for general adult education. Although the article is on a very general level, special points of interest are included: the employment of satellites as platforms from which to launch nuclear weapons, the desirability of strategic evaluation of cities, the ability of nuclear submarines to travel far under the ice, and emphasis on the task of ground forces to capture mobile or camouflaged missile-launching sites. 39 pp.

T-80. The role of science in modern warfare. Maj. Gen. G. I. Pokrovskii. Trans. by H. S. Dinerstein. 2-21-58. Unclassified.

A translation of a Russian article, entitled "Military Thought," which was published in March, 1955. Many of the developments considered then as possibilities have since been realized. Several items discussed in the article are noteworthy: (1) the possibility of using atomic weapons secretly by masking their explosive action from detection devices, (2) a description of rockets with readily mobile component parts, (3) the use of deep mines for civil defense, and (4) the speculation on technical problems of under-ice navigation for atomic submarines. 41 pp.

T-81. The equation of state of hydrogen at high pressures. A. A. Abrikosov. Trans. by Margaret Kivelson. 3-3-58. Unclassified.

An examination of the equation of state of hydrogen for $P > 2 \times 10^6$ atm. At 2.4×10^6 atm there exists a transition from the molecular to the atomic modification, accompanied by a discontinuous increase in the density from 0.621 gm/cm³ to 1.12 gm/cm³. The limits of applicability of the calculations are explored. 26 pp. Illus. Published in the *Astronomical Journal* (Vol. 31, 1954) of the S. I. Vavilov Institute of Physical Problems of the Academy of Sciences of the USSR.

T-82. Soviet commentary on the doctrine of limited nuclear wars. V. Mochalov and V. Dashichev. Trans. by Leon Gouré. 3-5-58. Unclassified.

A translation of an article, entitled "The Smoke Screen of the American Imperialists," which was published in *Red Star*, December 17, 1957. This article indicates that as the political and moral prestige of the U.S. has lessened during the "cold war" with the USSR, the American imperialist ideologists are developing the theory of "small" wars. The causes, courses, and objectives of such wars are discussed. It is concluded that restricting a war to certain areas or borders is impossible in view of modern-warfare methods. 11 pp.

T-83. Antiatomic defense in the Soviet air force. Trans. by Leon Gouré. 3-5-58. Unclassified.

A translation of an editorial, entitled "Each Airman Should Have Better Knowledge and Skill in Anti-atomic Defense," which appeared in *Sovetskaia Aviatsiia*, December 14, 1957. The article indicates that training under conditions approximating actual battle conditions, which takes into account a possible atomic attack, will help to round out the reactions of Soviet airmen, develop in them a high level of morale-fighting qualities, and contribute to the further growth of the fighting power of the Soviet Air Force. 7 pp.

T-84. Some Soviet views on air strategy. Trans. by Leon Gouré. 4-3-58. Unclassified.
Partial translations of several Soviet articles on air strategy, particularly on the state of the art in the United States. The first article, published in *Vestnik Vozdushnogo Flota*, considers the Soviet view of U.S.-NATO strategic doctrine. The other excerpts from *Sovetskaiia Aviatsiia* deal with American air strategy and discuss the impact of modern air technology on the conduct of war. 8 pp.

T-85-PR. The determination of orbits. A. D. Dubyago. Trans. by R. D. Burke, G. Gordon, L. N. Rowell, and F. T. Smith. July 1961. Unclassified.

A textbook covering the guiding principles for determining the orbits of celestial bodies (such as planets, comets, and meteors) revolving around the sun. Classical methods for attacking this problem are presented in a modern form characterized by the introduction of rectangular equatorial coordinates and suitable for use with a calculating machine. Attention is also given to such related topics as the calculation of orbit perturbations and the application of differential correction techniques to the determination of definitive orbits. 443 pp. Illus. Published under the same title by The Macmillan Company, New York, 1961. \$12.50.

T-86. On methods of analysis of some extremal problems in planning production.
L. V. Kantorovich. Trans. by R. D. Burke. 4-15-58. Unclassified.

A translation of a paper which appeared in the *Reports of The Academy of Sciences, USSR*, Vol. 115, No. 3, 1957. The methodology is presented for analysis of extremal problems in planning production. The author develops and explores a series of linear programming equations in establishing his major conclusions. 10 pp.

T-87. On the question of the pre-emptive blow by General of the Army V. Kurasov.
Trans. by H. S. Dinerstein. 5-12-58. Unclassified.

A translation of a Russian article which appeared in the April 27, 1958, issue of *Red Star*. The words preventive and pre-emptive war are used interchangeably in condemning both kinds of war as a "means of attack and of unleashing war... incompatible with the peaceful policy of the Soviet state, and... with socialist ideology." The author tries to demonstrate by quotations that the U.S. is planning to "unleash" a war by surprise and has achieved his propaganda purpose by skillful selection and omission. 17 pp.

T-88. Some special solutions of the boundary layer equations for a compressible fluid. A. Sh. Dorfman and E. T. Shvetz. Trans. by D. E. Coles. 5-15-58. Unclassified.

A translation of a Russian article concerning special solutions of the boundary-layer equations for a compressible fluid. The method is similar to that of Howarth, Stewartson, Cohen, and Reshotko. 8 pp.

T-89. Some results taken from observations of the first Russian earth satellites.
H. K. Paetzold. Trans. by J. F. Gross. 5-15-58. Unclassified.

A translation of a German paper concerning the state of the upper atmosphere as deduced from some observations of orbit changes and radio signals from Russian earth satellites. 20 pp. Illus.

T-90. Unified dynamics and thermodynamics of a thermal plasma. H. Maecker and Th. Peters. Trans. by J. F. Gross. 6-26-58. Unclassified.

A translation of a German paper which considers a unified theory to describe the dynamics and thermodynamics of a thermal plasma. This paper appeared in *Zeitschrift für Physik*, Bd. 144, S. 586-611 (1956). 40 pp. Table.

T-91. Russia's new middle class, by Alf Edeen. Trans. by W. P. Davison. 7-16-58. Unclassified.

A summary translation of a book entitled *Rysslands Nya Medelklass* (Russia's New Middle Class) by Alf Edeen, the chief Soviet affairs specialist in the Swedish Ministry of Defense. In addition to analyzing the social class composition of various Communist Party congresses, the author describes numerous ways in which the Soviet Union favors its new middle class. For instance, the progressive principle in income taxation stops at 1000 rubles per month, checking accounts earn interest at 3 per cent, and inheritance taxes are very light. 18 pp.

- Ø T-92. Theory and applications of the notion of complex signal. J. Ville. Trans. by Ivan Selin. 8-1-58. Unclassified.

An article translated from the French, which contributes to the problem of the composite representation of a signal by a two-dimensional distribution of energy in a domain defined by the time axis and the frequency axis. A distribution is proposed, using operators analogous to those used in quantum mechanics. 34 pp. Illus.

- T-95. On the prevention of surprise attack. Maj. Gen. N. Talenskii. Trans. by Oleg Hoeffding. 9-10-58. Unclassified.

A translation of a Russian article which discusses the Soviet proposal to prevent surprise attack by one state against another. In the author's view, the measures suggested provide sufficient opportunities for revealing the preparation of a surprise attack and for its prevention (i.e., the creation of observation posts at rail junctions, at major ports, and on motor highways). The proposal represents one part of a whole system of measures advanced by the Soviet government to alleviate international tension and end the armaments race. 7 pp.

- T-96. Mollier enthalpy-entropy charts for high-temperature plasmas. F. Bosnjakovic, W. Springe, K. F. Knoche, and P. Burgholte. Trans. by J. F. Gross. 8-25-58. Unclassified.

A translation of a German article presenting Mollier enthalpy-entropy diagrams for hydrogen and argon plasmas at temperatures up to 100,000°K and for pressures from 0.01 to 100 atm. The diagrams are shown with lines of constant pressure, density, temperature, and sonic velocity, and are further plotted in logarithmic coordinates to present the low-temperature region more clearly. 28 pp. Illus. See also T-99 and T-100. Presented before the American Society of Mechanical Engineers at Purdue University, Lafayette, Indiana, February 23-26, 1959.

- T-97. Some Soviet views on the nature of a future war and the factors determining its course and outcome. Trans. by Arnold Horelick. 9-15-58. Unclassified.

Translations of two Russian articles published in 1958. Colonel I. S. Baz' in "Soviet Military Science on the Character of Contemporary War" argues that wars of a given epoch are not only distinguished from each other, but have much in common, and depicts World War III as a prolonged attrition-type war. Colonel I. Korotkov in "The Basic Factors Determining the Course and Outcome of War" emphasizes the need to obtain superiority in the fundamental factors which determine victory, but deviates from the Baz' model by including space, surprise, and time among those basic factors. 53 pp.

- Ø T-98. Translations of two Soviet articles on law and order in outer space. A. Galina. Trans. by F. J. Krieger and J. R. Thomas. 9-25-58. Unclassified.

A translation of two Russian articles by A. Galina on the law and politics of outer space. They are entitled "On the Question of Interplanetary Law" and "For Equal Collaboration in the Peaceful Use of Cosmic Space." The articles examine the Soviet legal and political positions on problems of outer space and foreign military bases to be discussed before the General Assembly of the United Nations. 24 pp.

- T-99. Equilibria in a thermal plasma composed of $C + H_2$ and $C + 2H_2$ in a temperature range from 5000°K to 50,000°K at a total pressure of 1 bar. H. Kroepelin and K. K. Neumann. Trans. by J. F. Gross. 10-10-58. Unclassified.

A translation of a German article reporting the results of some theoretical calculations on the composition of a $C + H_2$ and $C + 2H_2$ plasma in the temperature range from 5000°K to 50,000°K at a total pressure of 1 bar. 34 pp. See also T-96 and T-100. Presented before the American Society of Mechanical Engineers at Purdue University, Lafayette, Indiana, February 23-26, 1959.

- T-100. Equilibria in $C + H_2$ and $C + 2H_2$ systems at temperatures between 1000°K and 6000°K. H. Kroepelin and E. Winter. Trans. by J. F. Gross. 10-6-58. Unclassified.

A translation of a German article on the influence of the temperature on the state of the chemical equilibria occurring in the gas phase of an electric arc during the decomposition of liquid hydro-

carbons. The influence of the total pressure in the system on the final appearance of the equilibria is calculated qualitatively. 33 pp. Illus. See also T-96 and T-99. Presented before the American Society of Mechanical Engineers at Purdue University, Lafayette, Indiana, February 23-26, 1959.

T-101. Radiation of plasma in a magnetic field. B. A. Trubnikov. Trans. by R. D. Burke. 10-8-58. Unclassified.

A translation of a Russian article which examines the radiation of plasma and the associated spiraling of electrons in a uniform magnetic field. The study is limited to the high harmonics of the radiation spectrum, and the distribution of electrons according to momentum is assumed to be isotropic. Formulae for finding the radiation of a layer of plasma in terms of radiation rate, absorption, layer thickness, and polarization are obtained. 12 pp.

Ø **T-102. On the probability of an n -coincidence.** A. R. Livshits. Trans. by W. I. Rumer. 10-15-58. Unclassified.

A translation of a Russian article published in *Radiotekhnika i Elektronika (Radio Engineering and Electronics)*, August 1957. The problem of determining the probability of pulse coincidence in n -pulse random sequences is examined. Formulas are derived to obtain both the probability and average duration of pulse coincidence in sequences containing pulses with equal or unequal pulse widths. 14 pp. Illus.

T-103. East bloc forgeries: a weapon in the cold war. Trans. by E. W. Schnitzer. 10-24-58. Unclassified.

A translation of an article from the West German news magazine *Der Spiegel* of October 8, 1958, dealing with Soviet document forgeries launched in the Communist-dominated East German newspaper *Neues Deutschland*. East Berlin today is the best propaganda-launching base in the direction of the West and the neutral world, and the number of forgeries (all believed to be produced in Moscow) is expected to increase. These forgeries have recently enabled Moscow to make dangerous inroads into American front lines of the cold war, to foster anti-American feeling in underdeveloped areas, and to confront the American government with a most intricate psychological warfare attack. 6 pp.

T-104. The development of Chinese Communist military forces. Trans. by E. W. Schnitzer. 11-7-58. Unclassified.

A translation of a German article published in the October, 1958, issue of *Wehrkunde*. The study deals with the history of the Chinese Communist soldier, the significance of the revolution, Mao's tactics of waging war, and the discipline of his soldiers. In addition, the basic factor distinguishing the Red Chinese armed forces from the Soviet forces is considered, together with the formation of people's communes in 1958 to militarize the rural population. 8 pp.

Ø **T-105. The interception problems of intercontinental missiles.** V. Kriksunov. Trans. by W. I. Rumer. 11-11-58. Unclassified.

A translation of a Russian article from the April 25, 1957, issue of *Soviet Aviation*. The article deals with the detection of missiles in flight, interception, and destruction. It contains interesting and provocative implications about Soviet thoughts on ICBM basing and operations in addition to anti-ICBM systems. 9 pp. Illus.

Ø **T-106. On an atomic airplane.** V. Artamkin. Trans. by C. M. Weber, Jr. 10-14-58. Unclassified.

A translation of a Russian article which appeared in the April, 1958, issue of *Atomic Energy*. The chief characteristics of an airplane with atomic engines are considered. A review is included, based on open literature, of the effort expended by England, France, and the United States toward creating an atomic airplane. 8 pp. Illus.

T-107. Soviet book review of A. S. Whiting's *Soviet policies in China, 1917-1924*. Trans. by J. R. Thomas. 11-18-58. Unclassified.

A review of A. S. Whiting's book *Soviet Policies in China, 1917-1924*, published in 1954 in *Sovetskoe Kitaevedenie*, a Soviet quarterly devoted to Chinese studies. The reviewer makes a major issue out of Soviet policy in Mongolia, denying Moscow's establishment of a sphere of influence in

the early twenties which excluded Chinese penetration for thirty years. He disavows Sino-Soviet friction over "joint" control of the strategic Chinese Eastern Railway which cut through Manchuria. The usual criticisms of a bourgeois work are made: the new era of socialist revolution is not recognized, nor are the relations of friendship and assistance to the weak countries by the more developed acknowledged. 18 pp.

- Ø T-108. Political control in the East German People's Army. Trans. by E. W. Schnitzer. 12-15-58. Unclassified.

A translation of an article from the November, 1958, issue of *Wehrkunde*, a West German military journal. The elaborate network of controls and means of supervision imposed on a Soviet satellite army is described in an armed force where suspicion and distrust rather than *esprit de corps* seem to be the outstanding morale factors. The article is significant in that the East German "National People's Army" at the moment is undoubtedly being readied for a role it may potentially play in the deepening German crisis. 10 pp.

- Ø T-109. Radiointerference phenomena caused by the ionosphere of the moon. G. A. Gurzadyan. Trans. by J. H. Huntzicker. 11-10-58. Unclassified.

A translation of an article published in the *Proceedings of the USSR Academy of Sciences*, 1958, Vol. 118, No. 5. The study examines the phenomenon of increased radio-frequency radiation from the sun preceding and following solar eclipses. Interference results from the difference in optical paths of radio rays originating at one point on the sun, some of which pass through and are refracted by the ionosphere of the moon. Results of a quantitative analysis are discussed, including patterns of interference predictable for point sources of solar radiation. 9 pp. Illus.

- Ø T-110. World-wide historic victory of the Soviet people. Trans. by J. R. Thomas. 1-29-59. Unclassified.

A translation from the May, 1955, issue of the Soviet General Staff journal *Military Thought*. From a political viewpoint, this editorial reviews the current Soviet opinion on the causes and results of World War II. From a military viewpoint the editorial indicates the weakness in Soviet military thinking and planning in the pre-World War II period, enumerates problems in the area of strategy and tactics as an aid to Soviet planners in future "emergencies," and discusses various factors which constitute long-range warning signs of possible war in the future. 35 pp.

- Ø T-111. The role of true absorption in the atmosphere of Mars. V. V. Sharonov. Trans. by D. S. Kirby. 2-6-59. Unclassified.

A translation of a Russian article published in *Astronomicheskii Zhurnal*, Vol. 34, No. 4, 1957. The paper analyzes the probable role of true absorption in the atmosphere of Mars and, in particular, the existence of a high-altitude "violet" layer in which particles absorb but do not scatter the rays of the violet end of the spectrum. Various conflicting hypotheses are evaluated, and internal inconsistencies are discovered. It is concluded that concrete arguments for or against the existence of such a layer in the Martian atmosphere cannot at present be adduced. 25 pp.

- Ø T-112. "Why the USA is straining to get into outer space." N. A. Alexandrov. Trans. by J. R. Thomas. 2-26-59. Unclassified.

A translation of a Russian article, published in the December 25, 1958, issue of *Soversky Flot* (*Soviet Fleet*), which discusses "peaceful" versus "military" uses of outer space. The Soviet desire to solve the problem of conquering the cosmos in the interest of mankind is stressed, whereas the United States position is stated as being strictly military. The Soviet Union wishes to solve the problem of cosmic space by forcing the Western powers to accept the Soviet proposal for an absolute ban of nuclear weapons. 9 pp.

- Ø T-114. German reports on East Bloc activities: central planning for atomic protection in the East Bloc; and ideological training in the East German People's Army. Trans. by E. W. Schnitzer. 6-9-59. Unclassified.

Two articles published in the May, 1959, issue of *Wehrkunde*, a West German military journal. The first translation, dealing with a secret East Bloc conference recently held at Budapest, indicates a determined effort to coordinate defense planning and protection against atomic attack on a common basis throughout the Soviet Bloc. The second translation reasserts Communist Party influence

over the armed forces of the East German state and stresses the changes instituted in the leadership structure of military forces since the downfall of Marshal Zhukov in 1957 in East Germany, in other satellite countries, and in the Soviet Union. 10 pp.

- Ø T-115. **The stellar ecospheres within a radius of 17 light-years around the sun.** Jan Gadoski. Trans. by H. B. Schechter. 6-11-59. Unclassified.

A translation of a German article that calculates the range of the ecospheres of those 59 stars situated within a radius of 17 light-years of the sun. Sixteen stars similar to the sun show broad ecospheres, while those of the other 43 subdwarfs are very narrow and will permit planets with only very limited ecological possibilities. 14 pp. Illus. Presented at the VIII International Congress on Astronautics at Barcelona, Spain, 1957.

- T-116. **"The airfield continues to operate."** Major S. Kovalev. Trans. by Leon Gouré. 6-25-59. Unclassified.

A translation of a Russian article that appeared in the May 6, 1959, issue of *Sovetskaia Aviatsiia*. The article relates the development of events at a Soviet air base, after warning of an atomic attack is given, to stress the importance of training to the Soviet flyer. 6 pp.

- Ø T-117. **Advances in meteorite research.** E. L. Krinov. Trans. by R. L. Neiswender. 7-7-59. Unclassified.

A translation of a report on the 8th Conference on Meteorites, held at Moscow, June 3-5, 1959, under the auspices of the Committee on Meteorites of the Academy of Sciences of the USSR. This Conference summarized the results of recent work in the field of meteorites and outlined future trends and concrete problems for further investigation. 3 pp.

- Ø T-118. **The approximate calculation of an ephemeris in unperturbed elliptic motion.** B. M. Shchigolev. Trans. by F. T. Smith. 10-9-59. Unclassified.

A Russian article that gives the approximate calculation of an ephemeris in unperturbed elliptic motion. The differential equations of motion for the two-body problem of celestial mechanics are non-linear due to the presence of a term proportional to the inverse cube of the distance between the bodies. The factor $1/r^3$ is averaged and replaced by a constant in the differential equations. Comparison ephemerides are calculated with these approximate expressions for several minor planets. 26 pp. See supplement T-119.

- Ø T-119. **Concerning the approximate calculation of an ephemeris in the restricted problem of three bodies.** B. M. Shchigolev. Trans. by F. T. Smith. 10-23-59. Unclassified.

A sequel to T-118, *The Approximate Calculation of an Ephemeris in Unperturbed Elliptic Motion*, also translated from the Russian. The problem discussed is that of determining, according to approximate formulas, the motion of an asteroid subject to the attractions of the Sun and Jupiter. 24 pp. Table.

- Ø T-120. **Calculation of the flight characteristics of a supersonic airplane with turbojet engines.** V. B. Lebedev. Trans. by C. M. Weber, Jr. 10-30-59. Unclassified.

An analytical approach used to find mathematical expressions for the interdependence of lift, drag, thrust, load factor, maximum speed, and ceiling. 17 pp. Illus. Translated from the *Bulletin of the Institutions of Higher Learning*, Ministry of Education, USSR, Aviation Technology Series, No. 4, 1958.

- Ø T-121. **Summit skirmishes in the cold war.** Trans. by E. W. Schnitzer. 12-22-59. Unclassified.

An article published in the November, 1959, issue of the German military journal *Wehrkunde*. The methods and aim of Soviet "summit diplomacy" are discussed, namely, to force Western recognition of the *status quo*, to build up the bases for further expansion of the Russian sphere of power and influence, to paralyze, as far as possible, Western defense preparedness, and to foster distrust among the Allies. The author is certain that the Soviet Union will continue to be aggressive and expresses the hope that the Western alliance will overcome its basic weaknesses, lack of political purpose, and military deficiency to be able to resist Soviet pressure. 21 pp.

- Ø T-122. "Military disengagement in Central Europe," a speech by *Bundestag* delegate Helmut Schmidt (SPD). Trans. by E. W. Schnitzer. 1-8-60. Unclassified.

A speech on military disengagement in Central Europe, delivered by Helmut Schmidt in the Foreign Policy Debate, held at the German Bundestag on November 5, 1959. The requirements that must be fulfilled in the case of regional disarmament in Central Europe are examined, together with some military objections to a zone of arms limitation in Central Europe. It is concluded that a zone of arms limitation in Central Europe would in no way adversely affect the principle of NATO's indirect defense in Europe. However, the real difficulties and motivations against this plan are of a psychological and political nature. 16 pp.

- Ø T-123. West European opinion on defense—No. 41: German polls of 1959 on rearmament, atomic energy, nuclear weapons, the balance of world power, and prospects of peace. Trans. by E. W. Schnitzer. 1-22-60. Unclassified.

Polls taken by two West German institutes for public-opinion research concerning Germany's obligation toward European defense, the necessity of rearmament, the blessing or curse of atomic energy to mankind, growing fear of atomic tests, the protection from atomic weapons, the balance of world power, the comparative strength of East and West in atomic weapons, the decreasing fear of war, and neutralism versus allegiance to the West. 12 pp.

- Ø T-124. Excerpts on the Ural-I and Ural-II Soviet digital computers. M. B. Penington, B. J. Scott, and W. H. Ware. 3-9-60. Unclassified.

A translation of some Soviet material on Ural I and II: a Table of Contents, Introduction, and table from *Programming for Digital Computing Machine, Ural-I*, and a Table of Instructions from *Digital Computing Machine Ural-II*. This machine is comparable to the small, automatic, universal, electronic digital computers. Any problem that can be solved arithmetically can be solved on Ural I and II. 27 pp. Illus.

- Ø T-125. The solution of linear differential equations by the method of the complete differential. L. N. Maurin. Trans. by F. T. Smith. 4-5-60. Unclassified.

A method of solution of linear differential equations that is a generalization of the method of Laplace. 9 pp. A translation from the Russian.

- Ø T-126. A comparison of the theoretically possible and actual procedures used in problem solving. A. H. Zakharov. Trans. by A. S. Kozak. 4-28-60. Unclassified.

A study, based on Whitfield's methodology, in which the theoretically possible procedures of problem solving are compared with solutions obtained by subjects in experiments. It is shown that the psychological difficulty in problem solving presented in the given experiments varies as a function of the nature of the information coming to the solver, that an increase in psychological difficulty is manifested with complete or partial nonuse (loss) of information necessary for the solution, and that the fundamental reason for the information loss lies in the use of inadequate procedures for solution. 20 pp. Table. Translated from the Russian.

- T-129. On the spectral theory of stochastic processes. Kari Karhunen. Trans. by I. Selin. 8-11-60. Unclassified.

A presentation of a succinct set of definitions and theorems concerning stochastic processes. Beginning with the definition of the correlation function, six theorems are given, involving the integral of a stochastic process, quadratically integrable stochastic processes, and the series representation of a stochastic process. Comparisons are made between the stated results and those obtained by other authors. 12 pp.

- T-131. On linear methods in probability theory. Kari Karhunen. Trans. by I. Selin. 8-11-60. Unclassified.

A summary of the most important properties of infinite sets of random variables, following Kolmogorov. The article constructs the Hilbert space corresponding to a given set of random variables with finite dispersions, discusses random functions and their simplest correlation properties, presents a new definition of the integral of a random function, defines the spectral representation of a random function, and considers applications of stationary random functions. 101 pp. Published in *Annales Academiae Scientiarum Fennicae Ser. A.I.* 37, Helsinki, 1947.

- Ø T-133. A specialized digital computer and an experiment in its use (a computer with reduced capabilities). V. A. Egorov. Trans. by A. S. Kozak and W. H. Ware. 10-11-60. Unclassified.

A Russian translation dealing with the specialized digital computer (STSM). The study describes the command structure and programming for the STSM, the character of the problems solved during 6 months of its operation, the advantages of STSM over larger computers, and its inadequacies. The need of more convenient computers with reduced capabilities is indicated. 20 pp.

- Ø T-134. Electronic digital machines and programming. A. I. Kitov and N. A. Krinitskij. Trans. by B. J. Scott and W. H. Ware. 12-30-60. Unclassified.

A translation of the table of contents and introduction of a Russian book, entitled *Electronic Digital Machines and Programming*. The book presents arithmetical, logical, and technical principles underlying the setup of high-speed computers. Although it is possible to use the basic ideas of the theory and methods of programming for other digital machines, almost all the examples cited are applicable to the machines known as STRELA, URAL, M-3, and BESM. The book is intended for students of universities and higher technical schools, and for workers in different branches of science and industry in which the new computing and control techniques may be applied. 44 pp.

- Ø T-135. Electronic computers in the service of the national economy. I. Bruk. Trans. by John Olney. 1-12-61. Unclassified.

A translation of a Russian article appearing *Kommunist*, No. 7, 1957. Electronic machines are discussed as a possible means to solve some very important economic problems confronting the USSR that, generally speaking, cannot be fully solved with less up-to-date technical means. The examples cited are the complex calculations connected with constructing a scientific price system, with determining the efficacy of capital investments, rate-setting, and wages, and with determining the structure of the national income. 11 pp.

- T-136. West German attitudes toward economic aid for underdeveloped areas. Trans. by E. W. Schnitzer. 1-20-61. Unclassified.

A translation from the November 1, 1960, issue of *DIVO Pressedienst*, the publication of a public opinion research institute in Frankfurt-am-Main. The poll considered deals with the attitudes of West Germans toward giving aid to underdeveloped countries. This subject has aroused considerable discussion in West Germany, not only in connection with the recent visit of Messrs. Anderson and Dillon to Bonn, but ever since affluent Germany has come under pressure from her Western allies to shoulder a greater part of Western aid. Unfortunately, the size of the sample polled is not given. However, the motivations listed and the breakdown into age, education, and party affiliation of the respondents make the survey useful for a better understanding of German attitudes toward aid. 8 pp. Tables.

- Ø T-137. A computer capable of learning. S. N. Braines. Trans. by A. S. Kozak. 3-1-61. Unclassified.

A discussion of a new type of automation that is capable of learning. It can formulate its own program and can modify it when new conditions of its operation arise. The study examines (1) the important bearing that the operation of the brain has on computer construction and (2) the value that a cybernetics computer can have in technology. 5 pp. A translation from *Izvestia*, No. 196, August 19, 1959.

- Ø T-138. Sublimation near the stagnation point of an axisymmetrical blunt body. S. V. Iordanski and Y. D. Shmilebski. Trans. by J. B. Gazley. 3-14-61. Unclassified.

A Russian translation from *Inzhenernyi Sbornik*, Vol. 28, 1960. Equations are obtained for the axisymmetrical laminar boundary layer of a two-component gas with low temperatures by calculating the diffusion. Boundary conditions are deduced for the case of a circumfluous body that is subliming. A method is given for the calculation of flow and velocity of sublimation near the stagnation point of the flow. Specific calculations are made for a body of solid carbon dioxide surrounded by a flow of air. The calculations show that marked diffusion of carbon dioxide gas into the air occurs. Conventionally the surface of the separation is not observed. 19 pp. Illus.

- Ø T-139. Calculation of required thrust taking into account compressibility. R. A. Kolchanov. Trans. by C. M. Weber, Jr. 4-14-61. Unclassified.

A method for determining graphically the relation among flight path, angle of attack, and required thrust of an aircraft by constructing a force polygon directly on the lift-drag polar. The method is used for conditions other than straight and level flight and, in the case of transition between subsonic and supersonic flight, can be used at any speed for which a polar can be obtained. 10 pp. Illus. Published in the *Bulletin of the Institutions of Higher Learning*, Ministry of Education, USSR, Aviation Technology Series, No. 4, 1960.

- Ø T-140. Calculation of the heating of two-layer plates. V. I. Figurovskii. Trans. by J. B. Gazley. 2-15-61. Unclassified.

An analysis of the heating of a two-layer plate. One layer consists of heat insulation, and the other is of metal. The equations obtained may be used for the heating calculation of a heat-insulated plate under any law of change of surface temperature with time. It is also possible to account for the change in the heat-transfer coefficient with time, and the physical heat properties of the materials. 11 pp. Illus. A translation from *Izvestiia Vysshikh Uchebnykh Zavedenii, Seriia "Aviatsionnaia Tekhnika,"* No. 2, 1960.

- T-141. On problems concerning the legal status of outer space. Trans. by J. K. T. Fong. 6-2-61. Unclassified.

A translation of an article appearing in a Red Chinese publication, *Kuo-Chi Wen-Ti Yen Chiu*, No. 8, December 1959. The author contends that the scientific probing of outer space will undoubtedly unfold in a context of conditions that will affect the law of space as it develops over the years. Thus the concept of outer space law and its various legal interpretations are of international significance. The "aggressive attempt of the United States imperialists" in connection with the use of outer space is said to aggravate the conflict between two camps over whether the exploration of outer space is for peaceful or for military purposes. 25 pp.

- Ø T-142. The experimental investigation of the subsonic turbulent boundary layer on a plate with injection. V. P. Mugalev. Trans. by J. B. Gazley. 12-8-60. Unclassified.

Experiments conducted with a porous plate to study the influence of injection of air on the velocity profile in the boundary layer. It is concluded (1) that flow in the boundary layer with injection is analogous to flow at an impermeable surface with a positive pressure gradient, (2) that velocity profiles at small injections are similar to power profiles, but at large injections they are similar to jet profiles, and (3) that the intensity-of-injection parameter characterizes the influence of the injection on the turbulent boundary layer. 17 pp. Illus. Translation of a Russian article published in *Izvestiia Vysshikh Uchebnykh Zavedenii: Aviatsionnaia Tekhnika*, No. 3, 1959.

- Ø T-143. A probability model of perception. E. N. Sokolov. Trans. by D. G. Hays and A. S. Kozak. 6-5-61. Unclassified.

A translation of a Russian article published in *Voprosy Psikhologii*, No. 2, March 1960. This study schematizes some general principles of perception of complex images, presented in a plane by a system of separate points. An experimental test of the theory is given in an example of tactile perception of letter images. 27 pp. Illus.

- Ø T-144. Heat and mass exchange with a solid-gas phase change on the surface of a body. E. P. Vaulin. Trans. by J. B. Gazley. 6-1-61. Unclassified.

An examination of a flat plate situated at zero angle of attack in the flow and blown by a gas that does not interact with the substance of the plate. The conditions of flow are such that on the surface of the plate a solid-gas phase change (sublimation) occurs. An attempt is made to determine the distribution of the products of sublimation, the velocity of sublimation, and the thermal flow along the plate. The problem is solved by the boundary-layer method. 18 pp. A translation of a paper presented before the Conference on Heat and Mass Transfer with Phase and Chemical Conversions, held at Minsk, Byelorussia Soviet Socialist Republic, June 5-9, 1961.

- Ø T-145. On the analysis of heat and mass transfer in binary gas mixtures. A. V. Luikov.
Trans. by J. B. Gazley. 3-24-61. Unclassified.

A derivation of a system of differential equations for heat and mass transfer in moving binary gas mixtures. On the basis of experimental data, the empirical dependence among the Dufour criterion, the mean temperature, and the initial concentration of several isotopic and nonisotopic mixtures is established. In contrast to the usual method of analysis of heat and mass transfer in gaseous mixtures, molecular transfer of heat and matter is examined by calculating thermal diffusion and diffusional heat conduction. 19 pp. Illus. Translation of a Russian article published in *Inzhenerno-Fizicheskii Zhurnal*, Vol. II, No. 11, 1959.

- T-146. Digital computers in the Soviet Union. V. Czapla. Trans. by Richard Stahl.
Annotated by W. H. Ware. 7-28-61. Unclassified.

A survey of the manufacture and use of digital computers in the Soviet Union. A tabulation of the specifications of various Soviet computers is included. 8 pp. Illus. An article translated from the German and published in *Mathematik-Technik-Wirtschaft*, No. 1, 1961.

PART III

AUTHOR INDEX

AIRCRAFT DIVISION

- ★ R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes
- R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes: Turbofan Engine Supplement
- RM-1009 Turboprop Engine Characteristics
- RM-1179 Preliminary Study of Turbojets for Mach 2.75

ALCHIAN, A. A.

- ★ R-224 Economic Replacement Policy
- RM-260-1 Reliability of Progress Curves in Airframe Production
- RM-481 Reliability of Cost Estimates: Some Evidence
- RM-563 Estimating Output from Floor Space: Feasibility
- RM-2153 Economic Replacement Policy
- RM-2190-RC An Economic Analysis of the Market for Scientists and Engineers
- P-108 An Airframe Production Function
- P-1449 Costs and Outputs
- P-1488 The Meaning and Validity of Inflation-induced Business Profits Resulting from a Lag of Wages behind Prices
- P-2316 Some Economics of Property

ALEXANDER, L. T.

- P-662 Systems Behavior—I: The Learning Process

ALMOND, G. A.

- RM-1506-RC The Politics of German Business

ALVAREZ, L. W.

- RM-4 Thermodynamic Properties of Metals

AMPEX CORPORATION

- RM-2110 Wide-band Magnetic Tape Recorder

ANDERSON, D. R.

- RM-1341 On the Solution of an Approximate Equation in the Theory of Optimal Allocation
- P-1152 On the Estimation of the Kloosterman Sum

ANDERSON, T. W.

- RM-224 A Mathematical Model of an Air Transportation System
- RM-284 Some Statistical Problems Connected with Stochastic Processes
- P-169 Some Statistical Problems Connected with Stochastic Processes

ANSOFF, H. I.

- RM-350 The Rayleigh-Ritz Method in Compressible Flow Problems

ARIS, R.

- P-1798 Some Optimization Problems in Chemical Engineering

ARMER, P.

- RM-15 The Location of the Maximum of a Function of Two Independent Variables When the Dependent and Independent Variables Are Measured without Error
- P-509 Applications of a Cathode Ray Tube Readout Device for the IBM 701 Electronic Data Processing Machine
- P-969 SHARE: A Eulogy to Cooperative Effort
- P-2114-1 Attitudes toward Intelligent Machines

★ Indicates publications which are out of print.

ARMERDING, G. W.

- P-2460 Statistics on the First Six Million Prime Numbers
- P-2500 A Short Table of Prime Numbers
- P-2552 A One-day Look at Computing

ARROW, K. J.

- R-318 A Time Series Analysis of Interindustry Demands
- RM-224 A Mathematical Model of an Air Transportation System
- ★ RM-291 Social Choice and Individual Values
- RM-373 On Mandelbaum's Study of the Industrialization of Backward Areas
- ★ RM-412 A Note on Best Strategies
- RM-456 Methodology Problems in Airframe Cost-Performance Studies
- RM-536 Cost-Quality Relations in Bomber Airframes
- RM-674 Note on the Problem of Aggregation
- RM-1976 Notes on Linear Programming—Part XLIII: A Feasibility Algorithm for One-way Substitution in Process Analysis
- RM-2190-RC An Economic Analysis of the Market for Scientists and Engineers
- RAOP-37 Bayes and Minimax Solutions of Sequential Decision Problems
- RAOP-41 The Possibility of a Universal Social Welfare Function
- P-49 The Determination of Many-commodity Preference Scales by Two-commodity Comparisons
- P-189 Optimal Inventory Policy
- ★ P-223 A Gradient Method for Approximating Saddle Points and Constrained Maxima
- P-706 Reduction of Constrained Maxima to Saddle-point Problems
- P-928 Gradient Methods for Constrained Maxima
- P-941 A Feasibility Algorithm for One-way Substitution in Process Analysis
- P-942 The Combination of Time Series and Cross-section Data in Interindustry Flow Analysis
- P-1015 On Gradient Methods for Approaching Constrained Maxima
- P-1364-RC Price-Quantity Adjustments in Multiple Markets with Rising Demands
- P-1365-RC Dynamic Shortages and Price Rises: The Engineer-Scientist Case
- P-1847 Quasi-concave Programming
- P-1856-RC Economic Welfare and the Allocation of Resources for Invention

ARROW, S. S.

- RM-373 On Mandelbaum's Study of the Industrialization of Backward Areas
- RM-456 Methodology Problems in Airframe Cost-Performance Studies
- RM-536 Cost-Quality Relations in Bomber Airframes
- P-239 Comparisons of Input-Output and Alternative Projections, 1929-1939

ASH, M.

- RM-2396 On Control of Reactor Shutdown Involving Minimal Xenon Poisoning
- P-1500 On Control of Reactor Shutdown Involving Minimal Xenon Poisoning

ASHER, H.

- R-291 Cost-Quantity Relationships in the Airframe Industry

ASSALI, N. S.

- P-2565 Physicochemical Characteristics of Placental Transfer

AUGENSTEIN, B. W.

- RM-819 Shock Wave Interaction, or the Velocity Effect in H.E. Rounds
- RM-1459 Scientific Satellite-payload Considerations
- RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- P-60 The Simulation of Combustion Models in Wind Tunnels

AUSLANDER, L.

- P-2081-2 The Imbedding of Graphs in Manifolds

AUSTERN, N.

- RM-2077 Strong-shock Point-source Blast Wave in a Non-uniform Atmosphere

★ Indicates publications which are out of print.

AVERCH, H. A.

- P-2488-1 Behavior of the Firm Subject to External Regulatory Constraint
- P-2540 Some Investment Criteria for Underdeveloped Areas

BACKUS, W. A.

- RM-2445 Descriptive Guide to a Card Directory of U.S. Military Radio Communication Equipment

BAER, D. F.

- T-72 Excerpt from "Construction of Aircraft" (*Konstruktsii Samoletov*) Dealing with the Evolution and Uses of Soviet Airplanes

BAHRMAN, C. P.

- RM-417 Calculation of Specific Impulse and Other Rocket Performance Characteristics
- RM-432 An Approximate Method for the Determination of Maximum Ramjet Impulse
- RM-490 Lagrangian Interpolation Coefficients and the Calculation of Maxima and Minima and Points of Inflection

BAILEY, D. K.

- ★ RA-15028 Communication and Observation Problems of a Satellite
- ★ RA-15029 Study of Launching Sites for a Satellite Projectile
- RAOP-3 The G-layer of the Ionosphere
- RAOP-4 On a New Method for Exploring the Upper Ionosphere

BAILEY, H. H.

- P-1044 Principles of Self-contained Navigation
- P-2020 Appropriate Roles and Some Limitations of Man as a Guidance Component

BAKER, C. L.

- P-1145 *Digital Computer Programming: A Book Review*
- P-1245 Primes in the Thousandth Million

BALDWIN, W. W.

- R-210 A Study of Project SCOOP Linear Programming

BALES, R. F.

- RM-953 Some Group Interaction Models
- P-587 Social Interaction

BALLANTYNE, F. P.

- RM-1097 An Approximation for Computing the Survival of a Two-dimensional Diffuse Target
- RM-1415 A Two-machine-gun Duel with the Bomber Turret Vulnerable

BARAN, P.

- P-1989 A Digital Simulation of an Aided Adaptive Character Reading Machine
- P-1990 An Aided Adaptive Character Reader for Machine Translation of Languages
- P-1995 Reliable Digital Communications Systems Using Unreliable Network Repeater Nodes

BARANGER, M.

- RM-2118-AEC New Developments in the Theory of Pressure Broadening

BARANKIN, E. W.

- RM-674 Note on the Problem of Aggregation
- RM-900 Quantitative Theory of Human Behavior: The Single Individual

BARBOUR, A. A.

- RM-2685 Standardization of Automatic Test and Checkout Equipment: A Preliminary Discussion
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design

★ Indicates publications which are out of print.

BARLOW, E. J.

- P-1850 Is Deterrence Enough or Should We Be Prepared To Fight a General War in the 1960's?

BARNETT, H. J.

- P-208 Specific Industry Output Projections

BARON, M. L.

- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
P-2109 Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium

BATOR, F. M.

- P-2125 On Convexity, Efficiency, and Markets
P-2174 On the Uses of Economics: Theory, Policy, and Values
P-2219 On Capital Theory and Development Planning

BATTELLE MEMORIAL INSTITUTE

- ★ RA-15039 Ceramic Materials Research for Aircraft and Rocket Vehicles
- ★ RA-15042 Propellants for Supersonic Vehicles: Boron Compounds
- ★ RA-15044 Propellants for Supersonic Vehicles: Liquid Oxygen
- ★ RA-15046 Propellants for Supersonic Vehicles: Hydrogen Peroxide
- ★ RA-15047 Propellants for Supersonic Vehicles: Liquid Fluorine
- ★ RA-15048 Propellants for Supersonic Vehicles: Halogen Fluorides
- ★ RA-15056 Ceramic Materials Research in the United Kingdom for Aircraft and Rocket Vehicles
- RA-15073 Eighth Quarterly Report—Appendix I: Materials, Fuels, and Combustion Project
- ★ RA-15077 Short-time, High-temperature Properties of Heat-resisting Alloy Sheet
- RA-15079 Economic Survey: The Potential Production of Anhydrous Hydrazine, Propellant for Supersonic Vehicles
- ★ RA-15080 Titanium and Titanium-base Alloys
- RA-15081 Economic Survey: Selected Ferroalloy Metals for High-temperature Uses
- ★ R-104 An Appraisal of the Usefulness of Aluminum Alloys for Supersonic Aircraft and Guided-missile Construction
- ★ R-108 Calculations for Reactions of Chromium, Molybdenum, Titanium, and Tungsten with Oxygen, Nitrogen, Hydrogen, Carbon, and Sulfur
- R-116 Porous Ceramics for Transpiration Cooling
- ★ R-117 An Evaluation of Ceramic Materials for Aircraft and Rocket Vehicles
- R-121 Economic Survey: The Potential Availability of Ammonia, Nitric Acid, and Nitrogen Tetroxide, Propellants for Supersonic Vehicles
- ★ R-123 Calcium and Calcium-base Alloys
- R-124 Economic Survey: The Potential Production of Liquid Fluorine, Chlorine Trifluoride, and Other Fluorine Compounds, Propellants for Supersonic Vehicles
- R-127 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—I: Fuels
- R-129 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—II: Oxidizers
- R-131 Titanium and Titanium-base Alloys
- ★ R-137 The Formation of Refractory Coatings by Vapor-deposition Methods
- R-142 Mixing in Inhomogeneous Gas Jets
- R-146 The Effects of Temperature on the Mechanical Properties of Magnesium Alloys
- ★ R-147 Short-time, High-temperature Properties of Heat-resisting Alloy Sheet
- ★ R-156 Economic Survey: The Potential Production of Diborane, Pentaborane, and Aluminum Borohydride, Propellants for Supersonic Vehicles
- R-196 Physical Properties and Thermodynamic Functions of Fuels, Oxidizers, and Products of Combustion—III: Products of Combustion
- R-200 Molybdenum Alloys and Protection by Cladding
- R-209 Mechanical Properties of Ceramic Bodies
- R-211 Composite Metal Sheets for Structural Applications

★ Indicates publications which are out of print.

- ★ RM-113 Evaluation of Materials in the Elasto-plastic Range
- ★ RM-198 Economic Survey Report: Construction Materials for Aircraft and Guided Missiles, Electric-power Supply and Requirements
- ★ RM-333 Information on the Plastic Properties of Aircraft Materials and Plastic Stability of Aircraft Structures at High Temperatures
- RM-398 The Preparation of High-purity Boron
- ★ RM-438 Summary Report: Cyclic Heat-transfer Studies with Gases
- RM-504 Behavior of Commercial Hydrazine in Contact with Various Materials
- ★ RM-519 Hydrazine Synthesis and Dehydration
- RM-524 Working Tables of Thermodynamic Functions and Equilibrium Constants for Silicon, SiO, and SiO₂
- ★ RAOP-19 Calculation of the Composition of Multicomponent Propellant Gases
- ★ RAOP-26 The Application of the Schlieren Method to the Quantitative Measurement of Mixing Gases in Jets
- ★ RAOP-27 Estimated Thermodynamic Functions of Free Radicals in Combustion Gases
- ★ RAOP-28 The Automatic Sampling of Gases at High Temperatures and Pressures
- ★ P-46 Arc Melting of Refractory Metals, Such as Titanium, and Their Alloys
- ★ P-53 Titanium-base Alloys
- ★ P-54 A Method for Measuring Surface Heat Transfer Using Cyclic Temperature Variation
- ★ P-55 A Study of Freely Expanding Inhomogeneous Jets
- ★ P-63 The Effect of Oxygen, Nitrogen, and Hydrogen on Iodide-refined Titanium
- ★ P-71 The Vapor-phase Deposition of Refractory Materials: General Conditions and Apparatus
- ★ P-128 Kinetic Study of the Thermal Decomposition of Hydrazine Vapor in a Silica Vessel
- ★ P-178 Heat Recovery and Maximum Thermodynamic Efficiency in a Rocket
- ★ P-184 Forgeable Arc-melted Tungsten

BATTEN, E. S.

- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
- P-1727 The Summertime Reversal of Winds in the Lower Stratosphere
- P-2018 Wind Systems in the Mesosphere and Lower Ionosphere
- P-2477 The Mesosphere

BEALE, E. M. L.

- P-2404-1 The Use of Quadratic Programming in Stochastic Linear Programming
- P-2405 The Simplex Method Using Pseudo-basic Variables for Structured Linear Programming Problems

BEAN, E. E.

- RM-2451 A Model for Assessing the Effect of Maintenance on Missile Launch Probability
- RM-2701 Application of the Bayes Technique to Spare-parts Demand Prediction
- P-1696 An Analytical Model for Developing Optimal Ballistic Missile Maintenance Procedures
- P-2317 A Malfunction-generation Model for a Manned Simulation of ICBM Logistics
- P-2521 Quality Control and Reliability for Total Weapon System

BEAR, D. V. T.

- P-1480 A Note on the Relationship of Saving to the Rate of Interest, Real Income, and Expected Future Prices
- P-2093 The Importance of Individual Industries for Defense Planning
- P-2124 The Importance of Individual Industries for Defense Planning: Supplemental Data

BECKENBACH, E. F.

- RM-617 What Is a Sensitivity Analysis?

BECKER, A. S.

- RM-2432 Prices of Producers' Durables in the United States and the USSR in 1955
- P-1881 Comparisons of United States and USSR National Output: Some Rules of the Game
- P-2286 Economic Growth and Soviet-American Rivalry

★ Indicates publications which are out of print.

BECKMANN, M.

- RM-1488 Studies in the Economics of Transportation
- P-282 Efficient Transportation in Networks
- P-290 A Continuous Model of Transportation
- ★ P-308 Activity Analysis and the Prediction of Traffic Flows
- P-437 The Determination of Traffic in a Road Network: An Economic Approach
- P-448 The Allocation of Switching Work in a System of Classification Yards
- P-649 An Activity Analysis Approach to Location Theory

BEDROSIAN, E.

- RM-2259 On the Growth of Duty Cycle in Intermittent Communication Systems
- RM-3080-PR The Analytic Signal Representation of Modulated Waveforms
- P-1200 Weighted PCM
- P-1403 VHF and UHF Communication Antennas
- P-1684 A Note on the Computation of Single-sideband Peak Power
- P-1893 The Optimum Detection of Analog-type Digital Data
- P-1907 On the Noise Temperature of Coupling Networks

BELL, C. F., JR.

- R-382 Influence of Resource and Policy Changes on Aircraft Capabilities
- P-2453 Throw-away Maintenance Policies

BELLMAN, R. E.

- ★ R-245 An Introduction to the Theory of Dynamic Programming
- ★ R-256 A Survey of the Mathematical Theory of Time-lag, Retarded Control, and Hereditary Processes
- R-271 Dynamic Programming of Continuous Processes
- ★ R-295 Dynamic Programming
- R-313 Some Aspects of the Mathematical Theory of Control Processes
- R-350 Adaptive Control Processes: A Guided Tour
- RM-67 On the Concept of Utility and Decision-making
- RM-152 A Class of Games with Good, Pure Strategies
- RM-156 Some Elementary Inequalities
- RM-160 An Example of Bluffing with Pure Strategies
- RM-164 On a Minimum Problem
- RM-165 A Bomber-Fighter Duel
- RM-197 Application of Theory of Games to Identification of Friend and Foe
- RM-212 On Non-zero-sum Games and Stochastic Processes
- RM-234 A Note on the Monte Carlo Method and the Potential Equation
- RM-250 On a Particular Non-zero-sum Game
- RM-289 Occurrence of Improbable States in a Modified Ehrenfest Model—Part I
- RM-321 Occurrence of Improbable States in a Modified Ehrenfest Model—Part II
- RM-357 On Positive Transformations
- RM-645 On a Geometrical Game Connected with Sequential Analysis
- RM-647 On a General Class of Problems Involving Sequential Analysis
- RM-648 On a Transportation Problem
- RM-651 On a Problem in the Theory of Testing
- ★ RM-688 A Bibliography of the Theory and Application of Differential-difference, Renewal, and Related Functional Equations
- ★ RM-895 On Some Variational Problems Occurring in Dynamic Programming Theory—I
- RM-969 On a Class of Matrices with Known Characteristic Roots and Vectors
- ★ RM-972 On Some Variational Problems Occurring in the Theory of Dynamic Programming—II
- ★ RM-973 On Some Variational Problems Occurring in the Theory of Dynamic Programming—III
- ★ RM-978 On Some Variational Problems Occurring in the Theory of Dynamic Programming—IV

★ Indicates publications which are out of print.

- ★ RM-980 On Some Variational Problems Occurring in the Theory of Dynamic Programming—V
- ★ RM-994 On Some Variational Problems Occurring in the Theory of Dynamic Programming—VI
- RM-1069 On an Application of the Theory of Dynamic Programming to Bottleneck Problems in Production and Allocation
- ★ RM-1096 On a New Iterative Algorithm for Finding the Solutions of Games and Linear Programming Problems
- ★ RM-1125 On Continuous Versions of Dynamic Programming Problems—III: Two Interdependent Industries with No Capacity Constraints
- ★ RM-1126 On Continuous Versions of Dynamic Programming Problems—IV: Duality Theorems for Bottleneck Problems
- RM-1241 On the Limiting Behavior of Discrete Dynamic Programming Processes—I (The Gold-mining Problem)
- RM-1242 On the Limiting Behavior of Discrete Dynamic Programming Processes—II (A Direct Proof of Convergence)
- RM-1243 On the Limiting Behavior of Discrete Dynamic Programming Processes—III (The Generalized Gold-mining Problem)
- RM-1318 On the Minimization of $\int_0^T |1 - x(t)| dt$
- RM-1336 On the Computational Solution of Some Functional Equations in the Theory of Dynamic Programming
- RM-1337 On Multi-stage Games with Imprecise Payoff
- RM-1370 Functional Equations, Wiener Integrals, and Applications—I: Functional Equations
- RM-1741 On the Optimal Use of Guided Missiles—I: Allocation of Missiles
- RM-1742 On the Optimal Use of Guided Missiles—II: Dummy Missiles
- RM-1745 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel
- RM-1746 On the Computational Solution of Dynamic-programming Processes—II: On a Cargo-loading Problem
- RM-1747 On the Computational Solution of Dynamic-programming Processes—III: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Expected Damage
- RM-1748 On the Computational Solution of Dynamic-programming Processes—IV: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Probability of Success
- RM-1749 On the Computational Solution of Dynamic-programming Processes—V: A Smoothing Problem
- RM-1750 Computational Solutions of Dynamic-programming Processes—VI: On the Optimal-trajectory Problem
- RM-1751 On the Computational Solution of Dynamic-programming Processes—VII: Radar Nets
- RM-1752 On the Computational Solution of Dynamic-programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- RM-1859 Notes on Linear Programming—Part XXXIX: Slightly Intertwined Linear Programming Matrices
- RM-1888 On the Formulation of Dynamic-programming Problems—I
- RM-1889 On the Computational Solution of Dynamic-programming Processes—X: The Fly-away-kit Problem
- RM-1898 On the Formulation of Dynamic-programming Processes—IV: On the Allocation of Bombers and Decoys
- RM-1901 On the Computational Solution of Dynamic-programming Processes—IX: A Multi-stage Logistic-procurement Model
- RM-1904 Dynamic Programming and Stochastic Control Processes
- RM-2189 Some Applications of Dynamic Programming to Communication and Information Theory
- RM-2245 On the Computational Solution of Dynamic-programming Processes—XVI: Reliability of Multicomponent Devices

★ Indicates publications which are out of print.

- RM-2282 On the Computational Solution of Dynamic-programming Processes—XIV: Missile-allocation Problems
- RM-2288 Invariant Imbedding and Wave Propagation in Stochastic Media
- RM-2318 A Note on the Numerical Integration of Nonlinear Partial Differential Equations
- RM-2319 On the Computational Solution of Dynamic Programming Processes—XI: A Feed-back-control Problem
- RM-2354 On the Application of Dynamic Programming to a Class of Implicit Variational Problems
- RM-2396 On Control of Reactor Shutdown Involving Minimal Xenon Poisoning
- RM-2859-PR New Directions of Research in the Theory of Differential Equations
- RM-2883-PR On Systems of Linear Inequalities in Hermitian Matrix Variables
- RM-2891-PR On the Numerical Solution of a Differential-difference Equation Arising in Analytic Number Theory
- RM-2978-PR On the Approximation of Curves by Line Segments Using Dynamic Programming—II
- RM-3001-PR Poisson Summation Formulas for Groups—I: Finite Groups
- RM-3056-PR On the Maximum Transform and Semigroups of Transformations
- RM-3063-PR Functional Equations in the Theory of Dynamic Programming—XII: An Application of the Maximum Transform
- RM-3083-PR Some Questions concerning Difference Approximations to Partial Differential Equations
- RM-3084-PR Polynomial Approximation: A New Computational Technique in Dynamic Programming—I: Allocation Processes
- RM-3113-PR Some Numerical Results Using Quasilinearization for Nonlinear Two-point Boundary Value Problems
- RM-3122-PR On Asymptotic Behavior of Solutions of Second-order Differential Equations
- RAOP-38 On the Theory of Age-dependent Stochastic Branching Processes
- P-84 Some Two-person Games Involving Bluffing
- P-141 Recurrence Times for the Ehrenfest Model
- P-158 Expectations, Positive Transformations, and Tauberian Theorems
- P-159 On the General Moment Problem
- P-168 On Games Involving Bluffing
- P-173 On the Integral Equation $\lambda f(x) = \int_0^a e^{-(x-y)} f(y) dy$
- P-174 On an Equation Occurring in the Harmonic Analysis of Viscous Fluid Flow
- P-175 On Approximate Expressions for the Exponential Integral and the Error Function
- ★ P-220 Symmetric Three-person Games and the Concept of an Independent Point
- P-225 On the Iteration of Power Series in Two Variables
- P-230 On Some Dynamic Linear Programming Problems
- ★ P-232 On the Min Max of $\int_0^1 f(x) a(x) d(x) dt(x)$
- P-233 A Note on a Class of Integral Equations Related to the Bessel and Mathieu Functions
- P-329 On a Functional Equation Occurring in the Theory of Dynamic Programming
- ★ P-341 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-380 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-381 The Stability Theory of Differential-Difference Equations
- P-382 Studies in Functional Equations Occurring in Decision Processes
- ★ P-398 On Limit Theorems for Noncommutative Operations—I
- P-403 Effects of Surface Tension and Viscosity on Taylor Instability
- P-407 Bottleneck Problems and Dynamic Programming
- P-410 Some Functional Equations in the Theory of Dynamic Programming
- P-412 Inequalities
- P-423 Computational Problems in the Theory of Dynamic Programming
- P-433 A Functional Equation in the Theory of Dynamic Programming and Its Generalizations
- P-436 On the Continuous Gold-mining Equation
- P-454 Dynamic Programming and a New Formalism in the Calculus of Variations

★ Indicates publications which are out of print.

- P-455 Some Problems in the Theory of Dynamic Programming
- P-456 Some Combinatorial Problems Arising in the Theory of Multistage Processes
- P-457 On Some Applications of the Theory of Dynamic Programming to Logistics
- P-463 On Perturbation Methods Involving Expansions in Terms of a Parameter
- P-469 Notes on Matrix Theory—IV (An Inequality Due to Bergström)
- P-473 On a New Iterative Algorithm for Finding the Solutions of Games and Linear Programming Problems
- P-475 Equilibrium Analysis: The Stability Theory of Poincaré-Liapounoff and Extensions
- ★ P-480 On a Functional Equation Arising in the Problem of Optimal Inventory
- P-483 Bottleneck Problems, Functional Equations, and Dynamic Programming
- ★ P-485 On Limit Theorems for Noncommutative Operations—II: A Generalization of a Result of Koenig
- P-486 A General Survey of the Theory of Dynamic Programming
- P-490 Some Applications of the Theory of Dynamic Programming
- P-491 The Theory of Dynamic Programming as Applied to a Smoothing Problem
- ★ P-492 Studies on Bottleneck Problems in Production Processes
- ★ P-495 Dynamic Programming and the Calculus of Variations—I
- P-513 Monotone Convergence in Dynamic Programming and the Calculus of Variations
- P-550 The Theory of Dynamic Programming
- P-552 On the "Bang-Bang" Control Problem
- P-566 Some Functional Equations in the Theory of Dynamic Programming—I: Functions of Points and Point Transformations
- P-568 Decision-making in the Face of Uncertainty—I: Uncertain Outcome
- P-572 On the Optimal Inventory Equation
- P-574 Dynamic Programming and a New Formalism in the Theory of Integral Equations
- P-575 On a Quasi-linear Equation
- P-577 On an Iterative Procedure for Obtaining the Perron Root of a Positive Matrix
- P-580 On the Optimal Inventory Equation
- P-586 A Problem in the Sequential Design of Experiments
- P-589 Dynamic Programming and Multistage Decision Processes of Stochastic Type
- P-590 A Note on the Mean Value of Random Determinants
- P-593 Decision-making in the Face of Uncertainty—II
- P-594 Notes on Matrix Theory—VI
- P-597 Dynamic Programming and a New Formalism in the Calculus of Variations—I
- ★ P-598 On a General Method in the Theory of Inequalities
- P-631 Notes in the Theory of Dynamic Programming—II: A Functional Equation Arising in Allocation Theory
- P-632 Notes in the Theory of Dynamic Programming—III: Equipment Replacement Policy
- P-635 Perturbation Methods in Applied Mathematics
- P-636 Some Nonclassical Problems in the Calculus of Variations
- P-639 Variational Problems with Constraints
- P-640 Notes in the Theory of Dynamic Programming—IV: A Variational Problem with Constraints
- P-651 Mathematical Aspects of Scheduling Theory
- P-671 Functional Equations in the Theory of Dynamic Programming—II: Nonlinear Differential Equations
- P-676 Functional Equations in the Theory of Dynamic Programming—III: Multi-stage Games
- P-696 Some Aspects of the Theory of Dynamic Programming
- ★ P-702 On a New Class of Functional Equations in Analysis
- ★ P-703 On the Computational Solution of Some Large-scale Dynamic Programming Processes
- P-704 Functional Equations in the Theory of Dynamic Programming—V: Positivity and Quasi-linearity
- ★ P-705 Functional Equations in the Theory of Dynamic Programming—IV: Multistage Decision Processes of Continuous Type
- P-713 A Note on the Dynamics of a Disordered Linear Chain
- P-714 On a Class of Variational Problems

★ Indicates publications which are out of print.

- P-715 Notes on Matrix Theory—IX
- P-716 On a Generalization of Some Integral Identities Due to Ingham and Siegel
- P-721 Notes on the Theory of Dynamic Programming—V: Maximization over Discrete Sets
- P-755 Notes on Matrix Theory—X: A Problem in Control
- P-764 Functional Equations in the Theory of Dynamic Programming—VI: A Direct Convergence Proof
- P-765 Notes on Control Processes—I: On the Minimum of Maximum Deviation
- P-770 On Converses of Schwarz's Inequality
- P-771 Notes on the Theory of Dynamic Programming—VII: Transportation Models
- P-772 Limit Theorems for Noncommutative Processes—II: On a Generalization of the Stieltjes Integral
- P-773 Notes on the Theory of Dynamic Programming—VI: The Warehousing Model
- P-777 On a Generalization of the Fundamental Identity of Wald
- P-780 Dynamic Programming and the Numerical Solution of Variational Problems
- P-784 Eigenvalues and Functional Equations
- P-787 Dynamic Programming
- P-796 Dynamic Programming and Its Application to Variational Problems in Mathematical Economics
- P-807 On the Application of the Theory of Dynamic Programming to the Study of Control Processes
- P-821 On Explicit Solutions of Some Trinomial Equations in Terms of the Maximum Operation
- P-837 Multidimensional Maximization, Dynamic Programming, and Economic Lot Size
- P-839 On the Principle of Invariant Imbedding and Propagation through Inhomogeneous Media
- P-845 Notes on the Theory of Dynamic Programming—VIII
- P-859 Functional Equations in the Theory of Dynamic Programming—VII: An Integro-differential Equation for the Fredholm Resolvent
- P-866 On a Dynamic Programming Approach to the Caterer Problem—I
- P-869 Dynamic Programming and Lagrange Multipliers
- P-903 On a Class of Functional Equations of Modular Type
- P-917 On Some Applications of Dynamic Programming to Matrix Theory
- P-918 Notes on Matrix Theory—XIII: Slightly Intertwined Linear Programming Matrices
- P-938 On the Expansions of Some Infinite Products
- P-947 On Positive Definite Matrices and Stieltjes Integrals
- P-949 On the Role of Dynamic Programming in Statistical Communication Theory
- P-956 On the Linear Differential Equation Whose Solutions Are the Products of Solutions of Two Given Linear Differential Equations
- P-960 Hydrodynamical Stability and Poincaré-Lyapunov Theory—I
- P-976 On the Principle of Invariant Imbedding and Diffuse Reflection from Cylindrical Regions
- P-977 A Dynamic Programming Solution to a Cascading Problem Arising in Heavy Water Production
- P-996 On the Principle of Invariant Imbedding and One-dimensional Neutron Multiplication
- P-1000 On a Routing Problem
- P-1003 Dynamic Programming and Stochastic Control Processes
- P-1012 A Note on Monotone Convergence to Solutions of First-order Differential Equations
- P-1018 Notes on Matrix Theory—XIV: On the Jacobi Relation for the Bracket Symbol
- P-1038 Dynamic Programming and the Variational Solution of the Thomas-Fermi Equation
- P-1056 On the Construction of a Multi-stage, Multi-person Business Game
- P-1062 The Theory of Games
- P-1065 On the Non-negativity of Green's Functions
- P-1066 A Markovian Decision Process
- P-1067 A Note on the Numerical Integration of a Class of Nonlinear Hyperbolic Differential Equations
- P-1072 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel

- P-1081 Functional Equations in the Theory of Dynamic Programming—VIII: The Variation of Green's Functions—One-dimensional Case
- P-1082 On the Determination of Characteristic Values for a Class of Sturm-Liouville Problems
- P-1084 On the Variation of the Fredholm Resolvent
- P-1086 Multi-dimensional Maximization and Dynamic Programming
- P-1090 *Topological Dynamics*: A Book Review
- P-1095 Notes on Matrix Theory—XV: Multiplicative Inequalities Obtained from Additive Inequalities
- P-1097 Kronecker Products and the Second Method of Lyapunov
- P-1101 Terminal Control, Time-lags, and Dynamic Programming
- P-1102 On the Principle of Invariant Imbedding and Neutron Transport Theory—I: One-dimensional Case
- P-1113 Random Walk, Scattering and Invariant Imbedding—I: One-dimensional Discrete Case
- P-1125 On the Representation of the Solution of a Class of Stochastic Differential Equations
- P-1133 Dynamic Programming, Nonlinear Variational Processes, and Successive Approximations
- P-1139 Dynamic Programming and the Reliability of Multicomponent Devices
- P-1147 Dynamic Programming and Mean Square Deviation
- P-1148 Some New Techniques in the Dynamic-programming Solution of Variational Problems
- P-1150 Dynamic Programming and the Variation of Green's Functions
- P-1153 On the Non-negativity of Solutions of the Heat Equation
- P-1155 Dynamic Programming and the Computational Solution of Feedback Design Control Problems
- P-1175 Dynamic Programming, Successive Approximations, and Variational Problems of Combinatorial Nature
- P-1176 Functional Approximations and Dynamic Programming
- P-1194 On Communication Processes Involving Learning and Random Duration
- P-1207 On Inequalities for Differential Operators
- P-1223 On Weighted PCM and Mean Square Deviation
- P-1226 On the Computational Determination of the Nature of Solutions of Nonlinear Systems with Stochastic Inputs
- P-1227 Dynamic-programming Approach to Optimal Inventory Processes with Delay in Delivery
- P-1233 On a Differential Inequality of Cesari and Turner
- P-1239 Invariant Imbedding, Wave Propagation, and the WKB Approximation
- P-1252 Invariant Imbedding and Neutron Transport Theory—II: Functional Equations
- P-1260 On Convergent Perturbation Expansions
- P-1271 On a Generalization of a Result of Wintner
- P-1280 Stability Theory and Adjoint Operators for Linear Differential-Difference Equations
- P-1282 On the Computational Solution of Dynamic Programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- P-1284 Combinatorial Processes and Dynamic Programming
- P-1316 Asymptotic Series for the Solutions of Linear Differential-Difference Equations
- P-1331 Functional Equations in the Theory of Dynamic Programming—IX: Variational Analysis, Analytic Continuation, and Imbedding of Operators
- P-1332 Functional Equations in the Theory of Dynamic Programming—X: Resolvents, Characteristic Functions, and Values
- P-1333 Approximation in Policy Space, Linear, and Nonlinear Programming
- P-1356 On "Heuristic Problem Solving" by Simon and Newell
- P-1361 Representation Theorems and Inequalities for Hermitian Matrices
- P-1374 On the Application of Dynamic Programming to a Class of Implicit Variational Problems
- P-1380 Invariant Imbedding and Neutron Transport Theory: A Generalized Approach
- P-1390 Invariant Imbedding and Generalized Transport Theory: A Basic Stochastic Functional Equation
- P-1408 Invariant Imbedding and Neutron Transport Theory—III: Neutron-Neutron Collision Processes
- P-1413 Top Management Decision and Simulation Processes

BELLMAN, R. E.—continued

- P-1416 Dynamic Programming and Adaptive Processes—I: Mathematical Foundation
P-1417 On k th Best Policies
P-1440 On a Liouville Transformation for $u_{xx} + u_{yy} \pm a^2(x, y)u = 0$
P-1463 An Application of Dynamic Programming to the Determination of Optimal Satellite Trajectories
P-1470 Asymptotic Behavior of Solutions of Differential-Difference Equations
P-1471 Invariant Imbedding and Wave Propagation in Stochastic Media
P-1494 Functional Equations and Maximum Range
P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
P-1500 On Control of Reactor Shut-down Involving Minimal Xenon Poisoning
P-1508 On the Concepts of a Problem and Problem-solving
P-1512 On Inequalities with Alternating Signs
P-1529 Functional Equations, Wave Propagation, and Invariant Imbedding
P-1550-RC Some Mathematical Aspects of Chemotherapy—I: One-organ Models
P-1551 On an Application of Dynamic Programming to the Synthesis of Logical Systems
P-1560-RC The Distribution of a Drug in the Body
P-1573 Functional Equations in Adaptive Processes and Random Transmission
P-1580 The Research Frontier
P-1581 Simulation and Stimulation
P-1597 Sequential Machines, Ambiguity, and Dynamic Programming
P-1610 On Adaptive Control Processes
P-1613 Dynamic Programming, Invariant Imbedding, and Two-point Boundary Value Problems
P-1614 Invariant Imbedding, Random Walk, and Scattering—II: Discrete Versions
P-1643 Functional Equations and Successive Approximations in Linear and Nonlinear Programming
P-1653 Functional Equations and Theta-functions—I
P-1663 On the Limit of Solutions of Differential-Difference Equations as the Retardation Approaches Zero
P-1691 The Mathematical Theory of Control Processes
P-1699 A Mathematical Theory of Adaptive Control Processes
P-1700 Invariant Imbedding and Neutron Transport in a Rod of Changing Length
P-1766 What Is Dynamic Programming?
P-1778 Dynamic Programming and Feedback Control
P-1797 Transport Theory and Invariant Imbedding
P-1798 Some Optimization Problems in Chemical Engineering
P-1802 Directions of Mathematical Research in Nonlinear Circuit Theory
P-1804 Dynamic Programming and Classical Analysis
P-1805 The Failure of the Universities—I: Scientific and Technological
P-1835 Invariant Imbedding and Neutron Transport Theory—V: Diffusion as a Limiting Case
P-1843 Functional Equations in the Theory of Dynamic Programming—XI: Limit Theorems
P-1846 On the Separation of Exponentials
P-1858 Invariant Imbedding and Mathematical Physics—I: Particle Processes
P-1870 Asymptotic Behavior of Solutions of Linear Parabolic Equations
P-1898 On the Stability of Solutions of the Linearized Plasma Equation
P-1903 On the Foundations of a Theory of Stochastic Variational Processes
P-1911 Some Mathematical Aspects of Optimal Predation in Ecology and Boviculture
P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
P-1930 Perturbation and Renormalization—I
P-1952 Dissipation Functions and Invariant Imbedding—I
P-1964 Reduction of Dimensionality, Dynamic Programming, and Control Processes
P-1966 An Ergodic Theorem
P-1973 Dynamic Programming, Sequential Estimation, and Sequential Detection Processes
P-1991 A Mathematical Formulation of Variational Processes of Adaptive Type
P-2013 On the Computational Solution of Differential-Difference Equations

- P-2014 Invariant Imbedding, Conservation Relations, and Nonlinear Equations with Two-point Boundary Values
- P-2071 Invariant Imbedding and the Reduction of Two-point Boundary Value Problems to Initial Value Problems
- P-2083 Functional Equations in the Theory of Dynamic Programming—XII: Complex Operators and Min-Max Variation
- P-2094 Successive Approximations and Computer Storage Problems
- P-2102-RC Mathematical Models of Chemotherapy
- P-2104 The Reciprocity Formula for Multidimensional Theta Functions
- P-2122 Invariant Imbedding and Variational Principles in Transport Theory
- P-2128 Perspectives of Dynamic Programming
- P-2145 On Various Versions of the Defective Coin Problem
- P-2163 On the Fundamental Equations of Invariant Imbedding—I
- P-2182 On the Iterative Solution of Two-point Boundary Value Problems
- P-2189 Quasilinearization and Upper and Lower Bounds for Variational Problems
- P-2190 A Note on an Inverse Problem in Mathematical Physics
- P-2200 Some Numerical Experiments Using Newton's Method for Nonlinear Parabolic and Elliptic Boundary-value Problems
- P-2202 Invariant Imbedding and Random Walk
- P-2225 On the Approximation of Curves by Line Segments Using Dynamic Programming
- P-2233 On the Computational Solution of a Class of Nonlinear Differential-Difference Equations
- P-2237 Dynamic Programming Treatment of the Travelling Salesman Problem
- P-2241 Interrupted Stochastic Control Processes
- P-2243 On the Reduction of Dimensionality for Classes of Dynamic Programming Processes
- P-2251 On Variation-diminishing Properties of Green's Functions
- P-2268 On a New Computational Solution of Time-dependent Transport Processes—I: One-dimensional Case
- P-2284 Dynamic Programming and "Difficult Crossing" Puzzles
- P-2300 Mathematical Experimentation and Biological Research
- P-2303 From Chemotherapy to Computers to Trajectories
- P-2308 Dynamic Programming and Linear Prediction Theory
- P-2309 Renormalization Techniques and Mean Square Averaging—I: Deterministic Equations
- P-2320 On a New Functional Transform in Analysis: The Maximum Transform
- P-2335 Self-consistent Solutions of Deterministic and Stochastic Nonlinear Differential Equations
- P-2341 Wave Branching Processes and Invariant Imbedding—I
- P-2348 A q -Version of the Newton Interpolation Formula and Some Eulerian Identities
- P-2361 A Note on Perturbation Series
- P-2392-1 On Some Mathematical Recreations
- P-2393 On the Asymptotic Behavior of Solutions of Nonlinear Differential Equations
- P-2400 Mathematical Model-making as an Adaptive Process

BELZER, R. L.

- RM-203 Solutions of a Special Reconnaissance Game
- RM-319 Local Defense of Targets of Equal Value
- RM-387 Some Remarks on Best Strategies

BEMER, R. W.

- RM-595 Machine Method: Iterative Solution of Games

BENTON, A.

- RM-272 The Rate of Dissociation of Air

BERGSON, A.

- R-253 Soviet National Income and Product, 1940 through 1948
- R-367-PR The Real National Income of Soviet Russia since 1928

BERGSON, A.—continued

- ★ RM-122 National Income of the USSR in 1940: Preliminary Report
- RM-154 On the Territorial Coverage of Soviet Official Statistics for Years since 1939
- ★ RM-155 Comparisons of Bergson-Heymann and Baran Calculations of Soviet National Income for 1940
- ★ RM-278 National Income and the Disposition of Gross National Product in Adjusted Rubles, USSR, 1940
- ★ RM-283 National Economic Accounts of the USSR in 1948: Preliminary Report
- ★ RM-287 Disposition of National Product of the USSR in 1948 in Terms of Adjusted Ruble Prices
- ★ RM-328 Disposition of the Gross National Product of the USSR in 1937, 1940, and 1948
- RM-393 Profits and Subsidies in Soviet Economic Accounts
- ★ RM-566 National Economic Accounts of the USSR in 1944: Preliminary Report
- RM-767 Prices of Ordinary Rolled Steel in the Soviet Union, 1928–1950
- RM-778 Prices of Quality Rolled Steel in the Soviet Union, 1928–1950
- RM-802 Prices of Iron and Steel Products in the Soviet Union, 1928–1950: A Summary Report
- RM-920 Prices of Basic Chemical Products in the Soviet Union, 1928–1950
- RM-1030 Prices of Nonferrous Metals in the Soviet Union, 1928 to 1950
- RM-1071 Prices of Paints in the Soviet Union, 1928–1950
- RM-1112 Prices of Metalworking Equipment in the Soviet Union, 1928–1951
- RM-1136 Prices of Cement in the Soviet Union, 1928–1950
- RM-1186 Prices of Bricks in the Soviet Union, 1928–1950
- RM-1244 Prices of Industrial Electric Power in the Soviet Union, 1928 to 1950
- RM-1421 Prices of Fuelwood and Wood Products in the USSR, 1928–1950
- RM-1423 Prices of Coal and Peat in the Soviet Union, 1928–1950
- RM-1482 Prices of Miscellaneous Basic Industrial Products, USSR, 1928–1950
- RM-1497 Prices of Refined Petroleum Products in the USSR, 1928–1950
- RM-1522 Basic Industrial Prices in the USSR, 1928–1950: Twenty-five Branch Series and Their Aggregation
- RM-1557 Abbreviations for Price Handbooks Used in RAND Studies of the Prices of Soviet Basic Industrial Goods
- RM-1919 Prices of Basic Industrial Goods in the USSR, 1950 to 1956: A Preliminary Report
- RM-2544 Soviet National Income and Product, 1928–1948: Revised Data
- P-789 Prices of Basic Industrial Products in the USSR, 1928–1950
- P-2148-1 Soviet National Income

BERKOVITZ, L. D.

- RM-1877 Optimal Employment of Tactical Air Forces in Theater Air Tasks: A Game-theoretic Analysis
- RM-2137 Optimal Employment of Tactical Air Forces in Theater Air Tasks—II: A Game-theoretic Analysis
- RM-2399 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- RM-2772 A Variational Approach to Differential Games
- RM-2888-PR Variational Methods in Problems of Control and Programming
- RM-3012-PR A Differential Game without Pure Strategy Solutions on an Open Set
- P-717 On Differential Games with Integral Payoff
- P-1151 A Multimove Infinite Game with Linear Payoff
- P-1533 A Multimove Allocation Game
- P-1592 A Game Theory Analysis of Tactical Air War
- P-1914 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis
- P-2072 The Implications of Some Game-theoretic Analyses for War Gaming
- P-2187 An Optimum Thrust Control Problem
- P-2205 A Variational Approach to Differential Games
- P-2306 Variational Methods in Problems of Control and Programming

★ Indicates publications which are out of print.

BERMAN, E. B.

- RM-1417 A Proposal for a New Air Force Supply Procedure
- RM-1519 A Model of the Procurement-Repair Decision for a Spare Item
- P-647 An Optimal Inventory Policy for a Military Organization
- P-1493 Toward a New Weapon-system Analysis
- P-1796 The Normative Interest Rate
- P-2001 Toward a New System for Allocating the Cost of Capacity

BERNAUT, E.

- RM-371 The Political Meaning of the Kostov Trial in Sofia, Bulgaria, December, 1949
- RM-977 Ritual of Liquidation: The Case of the Moscow Trials
- RM-1004 The Statutes of the Communist Party: Democratic Façade and Totalitarian Reality
- RM-1674 Collective Leadership and the Political Police in the Soviet Union
- RM-1819 Soviet Collective Leadership
- P-171 Politburo Images of Stalin

BERNAUT, R.

- RM-920 Prices of Basic Chemical Products in the Soviet Union, 1928-1950
- RM-1071 Prices of Paints in the Soviet Union, 1928-1950
- RM-1136 Prices of Cement in the Soviet Union, 1928-1950
- RM-1186 Prices of Bricks in the Soviet Union, 1928-1950
- RM-1421 Prices of Fuelwood and Wood Products in the USSR, 1928-1950
- RM-1482 Prices of Miscellaneous Basic Industrial Products, USSR, 1928-1950
- RM-1522 Basic Industrial Prices in the USSR, 1928-1950: Twenty-five Branch Series and Their Aggregation
- P-789 Prices of Basic Industrial Products in the USSR, 1928-1950

BERTRAM, S.

- RM-1029 Transmission of Pulses over Voice-quality Telephone Lines

BEVERLY, R. S.

- P-1457 Communications Analysis in LP-I

BICKNER, R. E.

- RM-1380 Cargo Density and Air Transportation
- RM-1853 Cargo Density and Airlift
- P-724 Cargo Density Variations: A Challenge to Air Transport

BIEL, W. C.

- RM-890 The Systems Research Laboratory and Its Program
- P-661 Description of the Air-defense Experiments—I: The Physical and Cultural Environments
- P-1202 The Systems Research Laboratory's Air-defense Experiments

BILLINGSLEY, P. P.

- P-2092 Statistical Methods in Markov Chains

BJERKNES, J. A. B.

- P-887 Detailed Analysis of Synoptic Weather as Observed from Photographs Taken on Two Rocket Flights over White Sands, New Mexico, July 26, 1948

BJORK, R. L.

- RM-1707 The Atomic-hydrogen Gun
- RM-2332 Estimated Damage to Space Vehicles by Meteoroids
- RM-2600 Cratering from a Megaton Surface Burst
- P-943 Impurity-induced Localized Modes of Lattice Vibration in a Diatomic Chain
- P-1662 Effects of a Meteoroid Impact on Steel and Aluminum in Space
- P-1913 A Conservative Estimate of the Meteoroid Penetrating Flux
- P-1936 Comments on "The Effect of Micrometeorites on Reflecting Surfaces"
- P-1963 Meteoroids versus Space Vehicles
- P-2172 Meteoroid Hazard to Nuclear Power Stations in Space
- P-2370 Analysis of the Formation of Meteor Crater, Arizona: A Preliminary Report
- T-53 On the Problem of Cooling Atomic Rockets Which Utilize Thermonuclear Reactions

BLACKMAN, J. H.

- RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan
P-288 Transportation

BLACKWELL, D. H.

- RM-131 The Noisy Duel, One Bullet Each, Arbitrary Nonmonotone Accuracy
RM-152 A Class of Games with Good, Pure Strategies
RM-160 An Example of Bluffing with Pure Strategies
RM-165 A Bomber-Fighter Duel
RM-193 A Bomber-Fighter Duel—II
RM-197 Application of Theory of Games to Identification of Friend and Foe
RM-219 A Loud Duel with Equal Accuracy Where Each Duelist Has Only a Probability of Possessing a Bullet
RM-241 Comparison of Reconnaissances
RM-250 On a Particular Non-zero-sum Game
RM-427 A Reduction of General Two-person Games without Side Payments
RM-1570 The Prediction of Sequences
RAOP-37 Bayes and Minimax Solutions of Sequential Decision Problems
P-84 Some Two-person Games Involving Bluffing
P-159 On the General Moment Problem
P-168 On Games Involving Bluffing

BLAKESLEE, D. J.

- P-690 A System for Cataloguing Reference Material
P-1889 Empirical Relationships for Jet-flap Lift and Drag Prediction

BLEICH, H. H.

- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures
P-2066 Surface Waves in an Elastic Half-space

BLOXSOM, D. E.

- RM-2678 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow
P-2110 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow

BLUMENTHAL, I. S.

- R-336-RC Research and the Ulcer Problem
RM-1298 Effects of Impulsive Deflections on Ballistic Missile Trajectories
RM-2276 Minimal Impulse Requirements for Disorbiting Satellites

BOEING AIRCRAFT COMPANY

- ★ RA-15018 Factors Limiting the Operational Gross Weight of the B-17 and B-29 Bombardment Airplanes: App. III to Fourth Quarterly Reports, RA-15033 and RA-15034

BOHN, L. C.

- RM-2472 On Motives for "Disarmament" Research
P-1917 Psychological Inspection

BOHNENBLUST, H. F.

- RM-208 Reconnaissance in Game Theory
RM-427 A Reduction of General Two-person Games without Side Payments
P-57 Solutions of Discrete, Two-person Games
P-66 Games with Continuous, Convex Payoff
P-85 On a Theorem of Ville

BOHNERT, H. G.

- P-331 The Logical Structure of the Utility Concept

BOLDYREFF, A. W.

- RM-1532 Determination of the Maximal Steady-state Flow of Traffic through a Railroad Network

★ Indicates publications which are out of print.

P-446 The Effect of Reliability of "Supervisory" Equipment on the Accuracy of a "Supervised" System

P-537 Systems Engineering

P-687 Determination of the Maximal Steady State Flow of Traffic through a Railroad Network

P-2476 A Systems Engineering Approach to Reliability

BOOKER, H. G.

P-2041 A Local Reduction of F-region Ionization Due to Missile Transit

BORNET, V. D.

P-2494 Seeking Social Welfare Facts in a California County: Sacramento

BRADLEY, H. R.

RM-536 Cost-Quality Relations in Bomber Airframes

BRECKNER, N. V.

P-1744 Government Efficiency and the Military "Buyer-Seller" Device

BRENNAN, L. E.

RM-2467 Angular Accuracy of a Phased Array Radar

RM-2953-PR On the Effectiveness of Search Algorithms Based on Samples of Controlled Duration: Sequential Detection

P-2027 Angular Accuracy of a Phased Array Radar

BRISTOL, R. B., JR.

P-1255 Factors Associated with Income Variability

BROCK, P.

P-1226 On the Computational Determination of the Nature of Solutions of Nonlinear Systems with Stochastic Inputs

P-1508 On the Concepts of a Problem and Problem-solving

BRODE, H. L.

RM-1363-AEC Numerical Solutions of Spherical Blast Waves

RM-1377 The Influence of a Variable Atmosphere on the Blast from a High Burst

RM-1583-1 Close-in H-Bomb Effects

RM-1824-AEC Point Source Explosion in Air

RM-1825-AEC The Blast Wave in Air Resulting from a High-temperature, High-pressure Sphere of Air

RM-1913-AEC Space Plots of Pressure, Density, and Particle Velocity for the Blast Wave from a Point Source in Air

RM-1965 A Calculation of the Blast Wave from a Spherical Charge of TNT

RM-1974 Theoretical Solutions of Spherical Shock-tube Blasts

RM-2211 Reflection Factors for Normally Reflected Shocks in Air

RM-2349 Summary and Recommendations Regarding Underground Phenomenology

RM-2600 Cratering from a Megaton Surface Burst

RM-2624-AEC Cavity Explosion Calculations for the COWBOY Program

P-452 Numerical Solution of a Spherical Blast Wave

P-571-AEC Numerical Solutions of Spherical Blast Waves

P-582 The Blast from a Sphere of High-pressure Gas

P-975 A Calculation of the Blast Wave from a Spherical Charge of TNT

P-1933 Numerical Calculations of Blast Waves

P-1951 Weapons Effects for Protective Design

P-2263 A Case for Survival Deep Underground

BRODIE, B.

R-335 Strategy in the Missile Age

RM-1013 The Heritage of Douhet

RM-1842 Implications of Nuclear Weapons in Total War

RM-1866 Strategic Air Power in World War II

RM-2218 The Anatomy of Deterrence

RM-2224 The Meaning of Limited War

BRODIE, B.—continued

- P-360 Attitudes toward the Use of Force
- P-372 Military Demonstration and Disclosure of New Weapons
- P-444 Military Implications of Nuclear Weapon Developments
- P-524 Possible U.S. Military Strategies
- P-527 Some Notes on the Evolution of Air Doctrine
- P-669 The Influence of Mass Destruction Weapons on Strategy
- P-811 Nuclear Weapons and Changing Strategic Outlooks
- P-841 Strategy versus Tactics in a Nuclear Age
- P-968 Scientific Progress and Political Science
- P-1092 The Worth of Principles of War
- P-1096 A Psychoanalytic Interpretation of Woodrow Wilson: A Book Review
- P-1111 Some Strategic Implications of the Nuclear Revolution
- P-1118 Implications of Nuclear Weapons in Total War
- P-1222 The Meaning of Limited War
- P-1405 The Anatomy of Deterrence

BROM, J. R.

- RM-1428 Narrative Description of an Analytic Theater Air-Ground Warfare System
- RM-2735-PR Operational Criteria for the Design of Missile-readiness Testing Programs and Equipment
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- P-2269 Criteria for the Design and Use of Automated Missile Ground Equipment To Improve Missile Readiness

BROWAND, F. K.

- RM-2638 The Design and Test of a Zero-wave-drag Ring-wing Configuration

BROWN, B. B.

- R-292 Characteristics of Demand for Aircraft Spare Parts
- RM-38 Tests of the Randomness of Digits
- RM-1297 Analysis of the Demand Patterns for B-47 Airframe Parts at Air Base Level
- RM-1413 The Prediction of Demand for Aircraft Spare Parts Using the Method of Conditional Probabilities
- RM-1490 A Preferred Method for Designing a Flyaway Kit
- RAOP-44 Some Tests of the Randomness of a Million Digits
- P-1980 A Comparative Study of Prediction Techniques

BROWN, G. W.

- RM-76 Least-squares Approximations by Sums of Separable Functions
- RM-135 Estimation of Mortality Parameters
- RM-376 A Method for Choosing among Optimum Strategies
- P-78 Some Notes on Computation of Games Solutions
- P-78B Notes on the Solution of Linear Systems Involving Inequalities
- P-96 The Future of Mathematical Statistics and Quality Control
- P-113 History of RAND's Random Digits: Summary
- P-142 Solutions of Games by Differential Equations

BROWN, L. D.

- RM-2937-PR Optimal and Nearly Optimal Policies for a Class of Adaptive Control Processes

BROWN, T. A.

- P-2069 Hamiltonian Paths on Convex Polyhedra
- P-2081-2 The Imbedding of Graphs in Manifolds
- P-2085 The Representation of Planar Graphs by Convex Polyhedra
- P-2379 Entropy and Conjugacy

BROWN, W. M.

- P-1645 An Approximation Method for Large-angle Scattering of High-energy Scalar and Vector Waves

BROWNE, S. H.

- R-144 Theory of Blind Navigation by Dynamical Measurements
- ★ R-154 Theory of Errors in Automatic Navigation with Integrating Accelerometer Systems
- P-121 Theory of Blind Navigation by Dynamical Measurements

BRYLES, A. A.

- RM-1447-AEC Stark Fields from Ions in a Plasma
- RM-1682-AEC Calculation of Fields on Plasma Ions by Collective Coordinates
- RM-2314 Damage to X-ray Detectors by Meteorites
- P-488 W.K.B. Approximation through the Turning Point
- P-663-AEC Stark Fields from Ions in a Plasma
- P-849-AEC Calculation of Fields on Plasma Ions by Collective Coordinates
- P-1784-AEC Radial Distribution Functions from the Born-Green Integral Equation

BRUCK, R. H.

- P-2427 Finite Nets—II: Uniqueness and Imbedding

BRUECKNER, K. A.

- RM-1802-AEC The Correlation Energy of an Electron Gas at High Density
- P-985-AEC The Correlation Energy of an Electron Gas at High Density

BUCHHEIM, R. W.

- RM-1726 Motion of a Small Body in Earth-Moon Space
- RM-1730 Lunar Instrument Carrier: Attitude Stabilization
- RM-1941 Artificial Satellites of the Moon
- RM-2113-1 An Annotated Bibliography of RAND Space Flight Publications
- P-873 Artificial Satellites of the Moon
- P-1248 Lunar Flight
- P-1268 Lunar Flight Trajectories
- P-1387 Space Flight Trajectories, Navigation, and Maneuvers
- P-1428 Types of Space Flights
- P-1442 Some Aspects of Astronautics
- P-1453 Lunar Flight Dynamics
- P-1669 Space Flight for Man
- P-2099 Utilization of Space from a National Standpoint
- P-2108 Space Exploration: A National Challenge
- P-2353-1 Vehicle Dynamics: NSF/Stanford Rocket Propulsion Institute

BURKE, R. D.

- P-1698 Some Unique Problems in the Development of Qualified Translators of Scientific Russian
- T-85-PR The Determination of Orbits
- T-86 On Methods of Analysis of Some Extremal Problems in Planning Production
- T-101 Radiation of Plasma in a Magnetic Field

BYRNE, J. F. (MOTOROLA, INC.)

- P-1403 VHF and UHF Communication Antennas

CAHN, A. S., JR.

- P-1623 Reliability, Quality Control, and Simulation

CAIRNS, S. S.

- P-735 On the Partition of the Vertices of an n -Cube by an $(n-1)$ -Plane
- P-736 Balance Scale Sorting

CAMPBELL, H. S.

- P-1586 Random Simulation of an Air Base Inventory Control System for a Repairable Part
- P-1689 The Use of Numerical Simulation in the Development of Inventory Policy

★ Indicates publications which are out of print.

CAPRON, W. M.

- RM-2190-RC An Economic Analysis of the Market for Scientists and Engineers
P-1365-RC Dynamic Shortages and Price Rises: The Engineer-Scientist Case

CARHART, R. R.

- RM-1131 A Survey of the Current Status of the Electronic Reliability Problem
RM-1194 Scientific Uses for a Satellite Vehicle
P-315 Reliability in Guided Missile Systems
★ P-399 Complexity and Reliability in Electronic Equipment

CARR, C. R.

- RM-2474 A Stochastic Force Survival Model

CARTAINO, T. F.

- RM-1710 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
RM-2327 Military Supersonic Transports
RM-2539 Vehicles for Exploration on Mars
P-834 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
P-1539 Supersonic Transports
P-1575 Some Military Aspects of Supersonic Transports
P-1655 Design and Cost Considerations for High-altitude Aircraft Systems
P-1841 Vehicles for Exploration on Mars
P-2049 Low-cost Cargo Aircraft: Turboprop or Turbofan?

CHAMBERLAIN, J. W.

- P-2007 Some Consequences of Local Acceleration of Auroral Primaries

CHANG, H. H.

- P-1520 On the Drag of a Sphere Moving in a Partially Ionized Atmosphere

CHAO, C. C.

- P-2066 Surface Waves in an Elastic Half-space

CHAPMAN, J. G.

- RM-425 The Regional Structure of Soviet Retail Prices
RM-707-1 Retail Food Prices in the USSR, 1937-1948
RM-803-1 Retail Prices of Manufactured Consumer Goods in the USSR, 1937-1948
P-449 Real Wages in the Soviet Union, 1928-1952

CHAPMAN, R. L.

- RM-890 The Systems Research Laboratory and Its Program
RM-1916 Data for Testing a Model of Organizational Behavior
P-443 Systems Research and Personnel Management
P-658 Description of the Air-defense Experiments—III: Data Collection and Processing
P-740 The Background and Implications of the Systems Research Laboratory Studies
P-753 *Cogwheel*: A Film Story of Systems Research Laboratory's Activities
P-802 A Theory of Organizational Behavior Deriving from Systems Research Laboratory Studies
P-1074 Simulation in RAND's Systems Research Laboratory
P-1105 The History, Purpose, and Script of *Cogwheel*
P-1202 The Systems Research Laboratory's Air-defense Experiments
P-2133-1 Consumption Levels in the Soviet Union and the United States

CHARWAT, A. F.

- P-1994 Tentative Generalization of Leading-edge Viscous Interaction Phenomena
P-2113 Molecular Flow Study of the Hypersonic Sharp Leading Edge Interactions
P-2367 Near Free Molecule Flows: Review of Analysis and Results

★ Indicates publications which are out of print.

CHERRY, I.

- RM-2318 A Note on the Numerical Integration of Nonlinear Partial Differential Equations
P-1067 A Note on the Numerical Integration of a Class of Nonlinear Hyperbolic Differential Equations

CHESTER, J. M.

- RM-2627-PR Cost of a Hardened, Nationwide Buried Cable Network
P-1327 An Introduction to Guided Missiles

CHIAPPINELLI, B.

- RM-657 Use of the Special Program Device on the 417 Tabulator

CLAEYS, Y. M.

- ★ RM-273 A Compilation of Physical and Chemical Data Pertaining to Self-igniting Fuels for Ramjet Propulsion

CLARK, A. J.

- RM-1417 A Proposal for a New Air Force Supply Procedure
RM-1621 A Technique for Optimal Distribution of Available Stocks to Bases
RM-1647 A Concept of Mechanized Transportation Data Processing
RM-2220 Implementing Logistics Policies in Laboratory Problem I (LP-I)
RM-2297 A Dynamic, Single-item, Multi-echelon Inventory Model
P-647 An Optimal Inventory Policy for a Military Organization

CLARK, C.

- P-1056 On the Construction of a Multi-stage, Multi-person Business Game

CLARK, P. G.

- RM-1809 Vulnerability and Recuperation of a Regional Economy: A Study of the Impact of a Hypothetical Atomic Attack on New England
P-1719 Civil Defense for Williamstown?
P-2093 The Importance of Individual Industries for Defense Planning
P-2124 The Importance of Individual Industries for Defense Planning: Supplemental Data

CLASEN, R. J.

- R-393-PR Light Scattering on Partially Absorbing Homogeneous Spheres of Finite Size
P-2079 Mie Scattering with Complex Index of Refraction

CLEMENT, G. H.

- P-833 The Moon Rocket
P-880 Weapons System Philosophy
P-1915 Celestial Frontiers

CLUBB, O. E., JR.

- P-1595-RC The Effect of Chinese Nationalist Military Activities in Burma on Burmese Foreign Policy

COHEN, S.

- RM-2272-AEC Relativistic Self-consistent Calculation for the Normal Mercury Atom
RM-2372-AEC Relativistic Self-consistent Calculation for the Normal Uranium Atom
RM-2404-AEC Relativistic Self-consistent Calculation for the Normal Tungsten Atom
RM-2405-AEC Relativistic Self-consistent Calculation for the Normal Platinum Atom
RM-2406-AEC Relativistic Self-consistent Calculation for the Iron Atom
P-1777-AEC Relativistic Self-consistent Solutions for Atoms of Large Atomic Number

COHEN, S. T.

- ★ R-132 Scattering and Absorption of Gamma Rays and Neutrons
RM-32 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
★ RM-34 Determination of Shield Thickness for Attenuation of Air-scattered Gamma Radiation
★ RM-39 Bremsstrahlung Correction to Transmission of Gamma Rays through Thick Media
RM-766 Estimation of Bremsstrahlung Radiation from Ce¹⁴⁴ Powerplant
★ RAOP-40 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
P-157 Scattering and Absorption of Gamma Rays

★ Indicates publications which are out of print.

COLE, J. D.

- RM-848 Note on Directional Effects of Pressure Field of Moving Blast
- RM-1181 A Theoretical Treatment of Spalling
- RM-1351 Note on the Effect of Circulation in Heat Transfer
- RM-1633 Newtonian Flow Theory for Slender Bodies
- RM-1991 Sweepback Theory for Shock Waves at Hypersonic Speeds
- RM-2348 Lift of Slender Nose Shapes According to Newtonian Theory
- P-359 Constant-strain Waves in Strings
- P-467 Impulsive Loading on an Elastic Half-plane
- P-614 Elastic Stress Waves Produced by Pressure Loads on a Spherical Shell
- P-884 Elastic Stresses Produced in a Half Plane by Steadily Moving Loads
- P-926 Newtonian Flow Theory for Slender Bodies
- P-1270 Lift of Slender Nose Shapes According to Newtonian Theory
- P-1276 Note on the Lift of Slender Nose Shapes According to Newtonian Theory
- P-1337 Sweepback Theory for Shock Waves at Hypersonic Speeds
- P-1695 Some Interior Problems of Hydromagnetics
- P-1827 On One-dimensional Inviscid Magnetohydrodynamic Flow
- P-2008 One-dimensional Expansion of a Finite Mass of Gas into Vacuum
- P-2141 Similarity Solution for Cylindrical Magnetohydrodynamic Shock Waves Produced by a Line Current Which Increases Linearly with Time
- P-2293 Magnetically Driven Shock Waves
- P-2318 Analytic Methods and Approximations of MHD Problems
- T-34 Shock Waves in Isotropic Elastic Media

COLEMAN, S. R.

- RM-2820-PR Classical Electron Theory from a Modern Standpoint

COLES, D. E.

- T-88 Some Special Solutions of the Boundary Layer Equations for a Compressible Fluid

COLLBOHM, F. R.

- P-707 Project RAND
- P-1032 Scientific Aids to Decisionmaking: A Perspective

COLLINS RADIO CO.

- ★ P-58 Physiological Damage Due to Microwaves
- ★ P-81 An Electromagnetic Blood Flow Meter
- ★ P-99 A Comparative Study of the Temperature Gradients Produced by Various Thermogenic Agents
- ★ P-122 Effects of Intense Microwave Radiation on Living Organisms
- ★ P-123 End-cooling of Power Tube Filaments

COOKE, K. L.

- P-1280 Stability Theory and Adjoint Operators for Linear Differential-Difference Equations
- P-1470 Asymptotic Behavior of Solutions of Differential-Difference Equations
- P-1663 On the Limit of Solutions of Differential-Difference Equations as the Retardation Approaches Zero
- P-1870 Asymptotic Behavior of Solutions of Linear Parabolic Equations

COOPER, G.

- P-200 Taxation and Incentive in Mobilization
- P-301 Are We Sure about Dispersal?
- P-548 Is Dispersal Good Defense?

COOPER, I.

- RM-2519 A Mathematical Model of the Human External Respiratory System
- P-1143 Certain Fundamental Approaches to the Use of Biological Material in Space Devices
- P-1304 Certain Ecological Aspects of a Closed Lunar Base
- P-1406 Experiments in Interplanetary Biomigration and Space Contamination

★ Indicates publications which are out of print.

- P-1680 Triangle: Man, Machine, Space
 P-1811 A Mathematical Model of the Human External Respiratory System

CORONA, D. D.

- RM-2455 Misslogs: A Game of Missile Logistics

COURT, A.

- P-769 Climatology: Complex, Dynamic, and Synoptic

COVER, T. M.

- P-2450 Partially Controllable Random Walk

COWAN, L. G.

- P-1522 The Economic Development of Morocco

COWLES COMMISSION

- ★ R-193 Activity Analysis of Production and Allocation (Proceedings of a Conference)

- RM-676 Lagrange Multipliers Revisited (A Contribution to Nonlinear Programming)

CRAFT, C.

- P-1056 On the Construction of a Multi-stage, Multi-person Business Game

CRAIG, L. J.

- P-2239 The Analysis of Some Essential Considerations in Program Design of Real-time Control Systems

- P-2359 Overlapping Tessellated Communications Networks

CRAIN, C. M.

- RM-2172 A Possible Transponding System for an Artificial Asteroid

- RM-2740 D-layer Ionization Loss Rates

- P-1305 Propagation Considerations in Space Operations

- P-1394 Communications in Space Operations

- P-1518 Problems of Range Measurement with Special Application to the Establishment of an Orbit of an Artificial Asteroid

- P-2015 Ionization Loss Rates below 90 km

- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts

- P-2395 Broadcasting from Satellites

CRENCA, J. J.

- P-1724 Military Radio Communications Equipment Trade-offs

CROCKER, I.

- P-1576-RC Burma's Foreign Policy and the Korean War: A Case Study

CRUM, J. O.

- ★ RA-15027 Satellite Rocket Powerplant

CULBERTSON, J. T.

- RM-744 Flicker and Fusion in a Hypothetical Device for Light-intensity Discrimination

- P-296 Hypothetical Robots and the Problem of Neuroeconomy

- P-316 Even in Memoryless Robots There Is No Small Number of Central Cells Sufficient for All Input-Output Specifications

- P-378 Sense Data in Robots and Organisms

CULVER, W. H.

- R-363 An Application of Superconductivity to Inertial Navigation

- RM-1852 An Application of Superconductivity to Inertial Navigation

- RM-2592 The Possible Use of Atomic Nuclei as a Direction Reference in Inertial Space

- P-1171 The Maser: A New Type Molecular Amplifier for Microwave Radiation

- P-1967 Cryogenic Gyros

- P-2304 Nuclear Gyros

★ Indicates publications which are out of print.

CUTLER, L.

- P-842 Manual for the RAND-IBM Code for Linear Programming on the 704
P-909 Operating the Linear Programming Codes

DADANT, P. M.

- P-1675 Why Go Deep Underground?

DALKEY, N. C.

- RM-109 Construction of Group Preference Relations by Iteration
RM-296 A Numerical Scale for Partially Ordered Utilities
RM-724 A Generalization of Numerical Utilities
RM-727 The Use of Experts for the Estimation of Bombing Requirements: A Project Delphi Experiment
P-265 Equivalence of Information Patterns and Essentially Determinate Games

DALLIN, A.

- RM-1637 *Red Star* on Military Affairs, 1945-1952: A Selected, Annotated List of Articles in the Soviet Military Newspaper
RM-1875 Odessa, 1941-1944: A Case Study of Soviet Territory under Foreign Rule

DANSKIN, J. M., JR.

- ★ R-256 A Survey of the Mathematical Theory of Time-lag, Retarded Control, and Hereditary Processes
RM-618 A Simple Maximization Problem
★ RM-688 A Bibliography of the Theory and Application of Differential-Difference, Renewal, and Related Functional Equations
RM-818 Another Proof of the Minmax Theorem for Continuous Payoffs
RM-856-1 Proof of a Theorem of Hayes on the Location of the Roots of a Certain Entire Transcendental Function
★ P-211 Remark on the Minkowski Inequality
P-212 Dresher's Inequality
P-235 A Game over Function Space
★ P-262 A Simple Type of Game over Function Space, Convex for the Minimizing Player
P-293 An Extension of the Brown-Robinson Iterative Process for Finding the Value of a Game
P-381 The Stability Theory of Differential-Difference Equations
P-634 A Stockpiling Problem: Mathematical Treatment

DANTZIG, G. B.

- RM-914 Algorithm for Computing Optimum Distribution of Local Defense
★ RM-1019 Comments on J. von Neumann's *The Problem of Optimal Assignment in a Two-person Game*
RM-1264 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
RM-1265 Notes on Linear Programming—Part II: Duality Theorems
RM-1266 Notes on Linear Programming—Part III: Computational Algorithm of the Revised Simplex Method
RM-1267-1 Notes on Linear Programming—Part IV: Constructive Proof of the Minmax Theorem
RM-1268 Notes on Linear Programming—Part V: Alternate Algorithm for the Revised Simplex Method Using a Product Form for the Inverse
RM-1268A Notes on Linear Programming—Part V: A Product-form Tableau for Revised Simplex Method, Computing Appendix for RM-1268
RM-1270 Notes on Linear Programming—Part VII: The Dual Simplex Algorithm
RM-1274 Notes on Linear Programming—Part XI: Composite Simplex-Dual Simplex Algorithm—I

★ Indicates publications which are out of print.

- RM-1281 Notes on Linear Programming—Part XIII: Optimal Solution of a Dynamic Leontief Model with Substitution
- RM-1290 Notes on Linear Programming—Part XIV: A Computational Procedure for a Scheduling Problem of Edie
- RM-1328 Notes on Linear Programming—Part XV: Minimizing the Number of Carriers To Meet a Fixed Schedule
- RM-1367 Notes on Linear Programming—Parts VIII, IX, and X: Upper Bounds, Secondary Constraints, and Block Triangularity in Linear Programming
- RM-1369 Notes on Linear Programming—Part XVI: The Problem of Routing Aircraft—A Mathematical Solution
- RM-1374 Notes on Linear Programming—Part XVII: Linear Programming under Uncertainty
- RM-1375 Notes on Linear Programming—Part XVIII: Status of Solution of Large-scale Linear-programming Problems
- RM-1383 Notes on Linear Programming—Part XIX: The Fixed-charge Problem
- RM-1418 Notes on Linear Programming—Part XXI: On the Max Flow Min Cut Theorem of Networks
- RM-1432 Notes on Linear Programming—Part XXIII: A Production Smoothing Problem
- RM-1475 Notes on Linear Programming—Part XXII: Recent Advances in Linear Programming
- RM-1489 Notes on Linear Programming—Part XXVI: Computation of Maximal Flows in Networks
- RM-1553 Notes on Linear Programming—Part XXVII: Dilworth's Theorem on Partially Ordered Sets
- RM-1709 Notes on Linear Programming—Part XXXI: A Primal-Dual Algorithm
- RM-1832 Notes on Linear Programming—Part XXXV: Discrete-variable Extremum Problems
- RM-1833 Notes on Linear Programming—Part XXXVI: The Allocation of Aircraft to Routes—An Example of Linear Programming under Uncertain Demand
- RM-1864 Notes on Linear Programming—Part XXXVIII: Note on B. Klein's *Direct Use of Extremal Principles in Solving Certain Problems Involving Inequalities*
- RM-2209 Notes on Linear Programming—Part XLVII: Solving Linear Programs in Integers
- RM-2321 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem: Notes on Linear Programming and Extensions—Part 49
- RM-2425 Computing Tetraethyl-lead Requirements in the Linear-programming Format: Notes on Linear Programming and Extensions—Part 52
- RM-2519 A Mathematical Model of the Human External Respiratory System
- RM-2751 On the Solution of Two-stage Linear Programs under Uncertainty: Notes on Linear Programming and Extensions—Part 55
- RM-2813-PR The Decomposition Algorithm for Linear Programming: Notes on Linear Programming and Extensions—Part 57
- RM-2957-PR Linear Programming in a Markov Chain: Notes on Linear Programming and Extensions—Part 59
- ★ P-392 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
- P-435 Comments on J. von Neumann's *The Problem of Optimal Assignment in a Two-person Game*
- P-440 The Product Form for the Inverse in the Simplex Method
- P-510 Solution of a Large-scale Traveling-salesman Problem
- P-561 The Problem of Routing Aircraft: A Mathematical Solution
- P-564 Constructive Proof of the Min-Max Theorem
- P-569 Notes on Linear Programming—Part XV: Minimizing the Number of Carriers To Meet a Fixed Schedule
- P-576 Upper Bounds, Secondary Constraints, and Block Triangularity in Linear Programming
- P-596 Linear Programming under Uncertainty
- P-610 A Production Smoothing Problem
- P-648 The Fixed Charge Problem
- P-652 Recent Advances in Linear Programming
- P-677 Computation of Maximal Flows in Networks

★ Indicates publications which are out of print.

DANTZIG, G. B.—continued

- P-727 The Allocation of Aircraft to Routes: An Example of Linear Programming under Uncertain Demand
- P-763 Note on B. Klein's *Direct Use of Extremal Principles in Solving Certain Problems Involving Inequalities*
- P-778 A Primal-Dual Algorithm
- P-824 Thoughts on Linear Programming and Automation
- P-826 On the Max Flow Min Cut Theorem of Networks
- P-876 Discrete Variable Extremum Problems
- P-891 The Simplex Method
- P-892 The Central Mathematical Problem
- P-893 Formulating a Linear Programming Model
- P-921 Upper Bounded Variables in Linear Programming
- P-980 Concepts, Origins, and Use of Linear Programming
- P-1028 On the Status of Multistage Linear Programming Problems
- P-1059 Chemical Equilibrium in Complex Mixtures
- P-1060 A Linear-programming Approach to the Chemical Equilibrium Problem
- P-1281 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem
- P-1345 On the Shortest Route through a Network
- P-1359 Solving Linear Programs in Integers
- P-1410 On Integer and Partial Integer Linear-programming Problems
- P-1448 An Equivalent Linear Programming Problem
- P-1459 Solving Two-move Games with Perfect Information
- P-1486 On the Significance of Solving Linear-programming Problems with Some Integer Variables
- P-1502 A Machine-job Scheduling Model
- P-1532 The Dual of a Transportation Problem Is Not a Transportation Problem
- P-1544 A Decomposition Principle for Linear Programs
- P-1545 Computing Tetraethyl Lead Requirements in the Linear-programming Format
- P-1646 New Directions in Mathematical Programming
- P-1664 General Convex Objective Forms
- P-1811 A Mathematical Model of the Human External Respiratory System
- P-1842 Linear Programming in a Markov Chain
- P-1851 Inductive Proof of the Simplex Method
- P-2039 On the Solution of Two-stage Linear Programs under Uncertainty
- P-2048 A Mathematical Model of the Chemistry of the External Respiratory System
- P-2056 Solving the Chemical Equilibrium Problem Using the Decomposition Principle
- P-2139 An Application of Mathematical Programming to Physiology: The Human Respiratory System
- P-2419 On the Reduction of Certain Multiplicative Chemical Equilibrium Systems to Mathematically Equivalent Additive Systems

DARLING, D. A.

- RM-195 The Problem of Cunningham and Hynd
- RM-284 Some Statistical Problems Connected with Stochastic Processes
- RM-448 The Survival Probability Problem
- RM-690 An Inventory Problem: The Bankruptcy Question
- RM-1973 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- P-169 Some Statistical Problems Connected with Stochastic Processes
- P-238 The First Passage for a Continuous Markoff Process
- P-429 On the Distribution of Certain Functionals of Markoff Processes
- P-738 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- P-1192 A New Approach to the Kolmogorov-Smirnov Distributions

DAVIES, M. E.

- RM-2183 A Photographic System for Close-up Lunar Exploration
- P-1671 Lunar Exploration by Photography from a Space Vehicle

- P-1892 How Good Is the Lunik III Moon Photography?
- P-1969 Analysis of Possible Lunik III Picture Hoax

DAVIS, D. J.

- RM-87 Examination of Some Models of Failure of Equipment during Operation
- RM-130 A Note on Vacuum Tube Life
- P-183 An Analysis of Some Failure Data

DAVIS, M. H.

- R-363 An Application of Superconductivity to Inertial Navigation
- RM-1852 An Application of Superconductivity to Inertial Navigation
- RM-2607 The Forces between Conducting Spheres in a Uniform Electric Field
- P-1920 A Comparison of Hydrodynamic and Electrostatic Forces on Cloud Droplets
- P-1967 Cryogenic Gyros

DAVIS, R. A.

- P-898 The Response of a Bisymmetric Aircraft to Small Combined Pitch, Yaw, and Roll Control Actions
- P-1693 Main Street and Mars
- P-1865 On the Future of Operations Research in the Aircraft and Space Systems Industries

DAVISON, W. P.

- R-302 The Berlin Blockade: A Study in Cold War Politics
- P-194 The Lesser Evil
- P-226 Some Observations on the Role of Research in Political Warfare
- P-570 A Review of Sven Rydenfelt's *Communism in Sweden*
- P-615 Psychological Aspects of Foreign Policy
- P-665 The Role of Mass Communications during the Berlin Blockade
- P-812 A Note on the Political Role of Mass Meetings in a Mass Communications Society
- P-851 Political Behavior in a Crisis: Some Observations from the Berlin Blockade
- P-1224 The Human Side of the Berlin Airlift
- P-1549 *The Cultural and Social Impact of an American Airbase upon an Urban French Community*. By Orvoell R. Gallagher: A Summary
- P-1869 Power: The Idea and Its Communication
- P-2042 A Public Opinion Game
- T-91 *Russia's New Middle Class*, by Alf Edeen

DEBEU, G.

- P-206 The Coefficient of Resource-utilization
- P-247 Definite and Semidefinite Quadratic Equations
- P-303 A Social Equilibrium Existence Theorem
- P-310 Numerical Representations of Technological Change
- P-318 Nonnegative Square Matrices
- P-357 A Classical Tax-subsidy Problem

De HAVEN, J. C.

- R-258-RC A Brief Survey of the Technology and Economics of Water Supply
- RM-2519 A Mathematical Model of the Human External Respiratory System
- P-879-RC The Nationalization of Research and Development in the U.S.
- P-1034-RC Feather River Water for Southern California
- P-1140-RC A Commentary on Fire Research
- P-1307 Why Beryllium?
- P-1349-RC Is Water Different?
- P-1372-RC The Relation of Salary to the Supply of Scientists and Engineers
- P-1467-RC Technology and the Challenge of the Future
- P-1625-RC Some Economic Features of Public Education
- P-1811 A Mathematical Model of the Human External Respiratory System
- P-2048 A Mathematical Model of the Chemistry of the External Respiratory System
- P-2136-RC The RAND Study of Water Supply
- P-2139 An Application of Mathematical Programming to Physiology: The Human Respiratory System

DeHAVEN, J. C.—continued

- P-2419 On the Reduction of Certain Multiplicative Chemical Equilibrium Systems to Mathematically Equivalent Additive Systems
P-2565 Physicochemical Characteristics of Placental Transfer

DEIRMENDJIAN, D.

- R-393-PR Light Scattering on Partially Absorbing Homogeneous Spheres of Finite Size
RM-2008 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
RM-2133 Theory of the Solar Aureole—Part II: Applications to Atmospheric Models
P-1190 Theory of the Solar Aureole—Part I: Scattering and Radiative Transfer
P-1287 Theory of the Solar Aureole—Part II: Applications to Atmospheric Models
P-1338 Temperature Dependence of the Rayleigh Scattering Coefficient in the Atmosphere
P-1426 Some Remarks on the Nature and Origin of Noctilucous Cloud Particles
P-1565 On the Role of Clear Sky Turbidity in Atmospheric Infrared Transmission
P-1880 Atmospheric Extinction of Infrared Radiation
P-2079 Mie Scattering with Complex Index of Refraction

De la MALÈNE, C.

- RM-1668-RC Paris from EDC to WEU
RM-2170-RC Attitudes of the French Parliament and Government toward Atomic Weapons

De LAND, E. C.

- RM-2519 A Mathematical Model of the Human External Respiratory System
P-852 The Steady, Axially Symmetric Flow of a Viscous Fluid in a Deep Rotating Cylinder Which Is Heated from Below
P-1635 Some Aspects of a Personnel Program for Computer Programmers
P-1811 A Mathematical Model of the Human External Respiratory System
P-1815 Continuous Programming Methods on an Analog Computer
P-2045 The Influence of Prandtl Number on the Heat Transfer from Rotating Non-isothermal Disks and Cones
P-2191 Some Experiments and Problems in Mathematical Biology
P-2307 Simulation of a Biological System on an Analog Computer
P-2461 By Automobile through Western Russia
P-2565 Physicochemical Characteristics of Placental Transfer

DENNIS, W. B.

- RM-575 Conversion of Interceptor Design Parameters and Cost to Air Battle Parameters for a 1954–1958 Air Battle Analysis

DENNY, B. C.

- P-2462-1 Science and Statecraft

DERR, J. I.

- P-693 Semi-automatic Allocation of Data Storage for PACT I
P-948 A Unified Process for the Evaluation of the Zeros of Polynomials over the Complex Number Field
P-1213 On Initial Estimates for Computing $a^{1/p}$ by Newton's Method

DESSLER, A. J.

- P-1860 Maximum Total Energy of the Van Allen Radiation Belt

DeWEERD, H. A.

- RM-2914-PR The Labour Party and Unilateralism
P-497 Atomic Weapons and Ground Combat: Search for Organization and Doctrine
P-697 Britain and the Defense of Western Europe
P-825 United States Policies on Disarmament, 1946–1955: A Critique
P-896 Disarmament Failure and Weapons Limitations
P-2059 The Korean War: Political Limitations
P-2351 American Attitudes toward War: Their Influence on Arms Control Proposals
P-2352 Concepts of Limited War: An Historical Approach
P-2390 British Defense Policy: An American View

- P-2509 Lord Russell, Unilateralism, and the Labour Party
- P-2542 Notes on a Conference with Soviet Scientists
- P-2562 Britain's Defense New Look Five Years Later

DEWEY, C. F., JR.

- P-2418 The Use of Local Similarity Concepts in Hypersonic Viscous Interaction Problems, and Application to Yawed Lifting Surfaces with Mass Transfer

DHANES, L. W.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics

DIGBY, J. F.

- RM-673 Flight Test of ASR-1 Radar at Low Altitudes
- P-1254 An Electronics Engineer's View of Operations Research

DINERSTEIN, H. S.

- ★ R-326 War and the Soviet Union: Nuclear Weapons and the Revolution in Soviet Military and Political Thinking
- RM-788 Political Vulnerability of Moscow: A Case Study of the October, 1941, Attack
- RM-923 Leadership in Soviet Agriculture and the Communist Party
- ★ RM-2102 The Soviet Military Posture as a Reflection of Soviet Strategy
- RM-2532 Soviet Strategic Ideas, January, 1960
- RM-2771 Military Force and Soviet Goals
- ★ P-370 The Soviet Purge: 1953 Version
- P-421 Purges in the Soviet Union and in the Satellites
- P-604 The Impact of Air Power on the International Scene, 1933-1940
- P-1317 The Soviet Employment of Military Strength for Political Purposes
- P-1925 Soviet Strategic Ideas, January, 1960
- T-73 Some New Soviet Material on Missiles
- T-77 Two Russian Articles on the Ballistic Missile
- T-79 The Role of Science and Technology in Modern War
- T-80 The Role of Science in Modern Warfare
- T-87 On the Question of the Pre-emptive Blow by General of the Army V. Kurasov

DISHINGTON, R. H.

- RA-15074 Evaluation of Missile Drift Caused by Wind
- RM-413 The Expected Coverage of a Small Circular Target by a Number of Circular Bombs

DIXON, W. J.

- RM-1094 Distributions of Surviving Bombers in Certain Air Battle Models

DOLE, S. H.

- RM-1900 Visual Detection of Light Sources On or Near the Moon
- RM-2542 The Sabatier Reaction for Inorganic Recovery of Oxygen in Manned Space Capsules
- RM-2668 Design Criteria for Rotating Space Vehicles
- RM-2879-PR The Gravitational Concentration of Particulate Matter in the Space near the Earth
- P-978 The Atmosphere of Venus
- P-1309 Internal Environment of Manned Space Vehicles
- P-1499 The Space Environment
- P-1577 Environmental Requirements for Extended Occupancy of Manned Satellites
- P-1639 Sources, Availability, and Estimated Costs of Propellants
- P-1970 Problems and Concepts of General Planetology
- P-1992 Limits for Stable Near-circular Planetary or Satellite Orbits in the Restricted Three-body Problem

DOMAR, E. D.

- P-325 Depreciation, Replacement, and Growth

DOUGHERTY, C. B.

- P-359 Constant-strain Waves in Strings

★ Indicates publications which are out of print.

DOWDY, A. H., M.D.

RM-18 Medical and Biological Aspects of Nuclear Energy

DOYLE, W. L., JR.

RM-2987-PR Approximate Band-pass Limiter Envelope Distributions

RM-3090-PR Interpolation and Extrapolation of Stationary Random Sequences

P-2449 Operations Useful for Similarity-invariant Pattern Recognition

DRESHER, M.

★ R-115 Mathematical Theory of Zero-sum Two-person Games with a Finite Number or a Continuum of Strategies

★ R-216 Theory and Applications of Games of Strategy

R-360 Games of Strategy: Theory and Applications

RM-31 Ville's Example of a Game without a Strategic Saddle-point

RM-33 Two Theorems Concerning Solutions for Games with Continua of Strategies

RM-319 Local Defense of Targets of Equal Value

RM-320 Local Defense of Targets of Equal Value: Extension of Results

RM-534 Moment-space Boundaries and Some Applications

RM-1335 Optimal Tactics in a Multistrike Air Campaign

RM-1877 Optimal Employment of Tactical Air Forces in Theater Air Tasks: A Game-theoretic Analysis

RM-2137 Optimal Employment of Tactical Air Forces in Theater Air Tasks—II: A Game-theoretic Analysis

RM-2399 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis

RM-2723 Optimal Timing in Missile Launching: A Game-theoretic Analysis

P-100 Polynomial Games

P-103 Method of Solution in Game Theory

P-245 An Analysis of Three-move Finite Games

P-252 Moment Spaces and Inequalities

P-255 Solutions of Convex Games as Fixed-points

P-994 Theory of Games of Strategy

P-1151 A Multimove Infinite Game with Linear Payoff

P-1533 A Multimove Allocation Game

P-1592 A Game Theory Analysis of Tactical Air War

P-1849 Some Military Applications of the Theory of Games

P-1914 Allocation of Two Types of Aircraft in Tactical Air War: A Game-theoretic Analysis

DRESSIN, S. A., MAJ., USMC

P-846 Priority Assignment on a Waiting Line

DREYFUS, S. E.

RM-1710 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem

RM-1745 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel

RM-1746 On the Computational Solution of Dynamic-programming Processes—II: On a Cargo-loading Problem

RM-1747 On the Computational Solution of Dynamic-programming Processes—III: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Expected Damage

RM-1748 On the Computational Solution of Dynamic-programming Processes—IV: On the Optimal Use of Guided Missiles against a Fixed Target System—Maximum Probability of Success

RM-1749 On the Computational Solution of Dynamic-programming Processes—V: A Smoothing Problem

RM-1750 Computational Solutions of Dynamic-programming Processes—VI: On the Optimal-trajectory Problem

★ Indicates publications which are out of print.

- RM-1751 On the Computational Solution of Dynamic-programming Processes—VII: Radar Nets
- RM-1752 On the Computational Solution of Dynamic-programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- RM-1888 On the Formulation of Dynamic-programming Problems—I
- RM-1889 On the Computational Solution of Dynamic-programming Processes—X: The Fly-away-kit Problem
- RM-1898 On the Formulation of Dynamic-programming Processes—IV: On the Allocation of Bombers and Decoys
- RM-1901 On the Computational Solution of Dynamic-programming Processes—IX: A Multi-stage Logistic-procurement Model
- RM-2134 On the Computational Solution of Dynamic-programming Processes—XV: An Industrial Replacement Process
- RM-2245 On the Computational Solution of Dynamic-programming Processes—XVI: Reliability of Multicomponent Devices
- RM-2282 On the Computational Solution of Dynamic-programming Processes—XIV: Missile-allocation Problems
- RM-2319 On the Computational Solution of Dynamic-programming Processes—XI: A Feedback-control Problem
- P-834 Application of Dynamic Programming to the Airplane Minimum Time-to-climb Problem
- P-885 A Comparison of Linear Programming and Dynamic Programming
- P-924 Computational Aspects of Dynamic Programming
- P-932 An Analytic Solution of the Warehouse Problem
- P-1029 Dynamic Programming: Methods and Application
- P-1039 A Generalized Equipment Replacement Study
- P-1045 A Note on an Industrial Replacement Process
- P-1072 On the Computational Solution of Dynamic-programming Processes—I: On a Tactical Air-warfare Model of Mengel
- P-1083 Dynamic Programming Solution of Allocation Problems
- P-1139 Dynamic Programming and the Reliability of Multicomponent Devices
- P-1176 Functional Approximations and Dynamic Programming
- P-1282 On the Computational Solution of Dynamic-programming Processes—VIII: A Bottleneck Situation Involving Interdependent Industries
- P-1369 Introduction to Dynamic Programming
- P-1463 An Application of Dynamic Programming to the Determination of Optimal Satellite Trajectories
- P-1464 Dynamic Programming and the Calculus of Variations
- P-1527 Dynamic-programming Algorithms and Formulations
- P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
- P-2043 The Computational Solution of Variational Problems
- P-2158 The Analysis and Solution of Optimum Trajectory Problems
- P-2334 A New Approach to the Duality Theory of Mathematical Programming
- P-2357 Variational Problems with Inequality Constraints
- P-2374 The Numerical Solution of Variational Problems

DUBOIS, D. F.

- RM-2899-AEC Quasi-classical Theory of Electron Correlations in Atoms
- RM-3050-PR Collision Damping of Plasma Oscillations

DUGAS, D. J.

- RM-2825-PR Solar-flare Radiation and Manned Space Flight

DUKE, C. M.

- P-1762 Effects of Earthquakes on Tunnels

DUNLAP AND ASSOCIATES, INC.

- RM-2756-PR Human Factors in Automatic Checkout Equipment: An Annotated Bibliography

DVINOV, B. L.

- ★ P-768 Politics of the Russian Emigration
- ★ P-865 Documents on the Russian Emigration: An Appendix to RAND Paper P-768

DYE, H. M.

- RM-844 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part I: Noses and Cylinders
- RM-905 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part II: Boattails

EARLY, L. B., JR.

- P-1353 General Description of a Cooperative Anticollision System for Aircraft

EASON, W. W.

- RM-1248 The Agricultural Labor Force and Population of the USSR: 1926-41
- P-289 Trends and Prospects of the Soviet Population and Labor Force
- P-551 Employment and Unemployment in the USSR

EASTMAN, S. E.

- P-734 Comments on Future Military Air Transport Requirements
- P-803 The Value of Airlift in Defensive, Local, or Peripheral Wars after 1960

ECONOMICS DEPARTMENT (Formerly known as the Economics Division)

- ★ RM-821-6 Selected List of Unclassified Publications of the Economics Division of The RAND Corporation
- RM-1924 First Tooling-up Exercise for Logistics Systems Laboratory (October-November, 1956)
- RM-1961 Second Tooling-up Exercise of Logistics Systems Laboratory (January-February, 1957)

EDELEN, D. G. B.

- RM-3031-PR On a Mechanical Interpretation of the Null Geodesics in Static Einstein-Riemann Spaces
- RM-3039-PR On the Characterization of Contemporaneous and Born Rigid Motions and the Question of Their Equivalence
- RM-3092-PR Augmentation Analysis of the Einstein Gravitational Field
- P-2100 An Affine Field Description of Gravitation Electromagnetism and Matter
- P-2368-1 On the Continuation of Orthogonal Structure across a Surface of Discontinuity in the Momentum-energy Tensor
- P-2369 Discontinuities in the Einstein-field for General Momentum-energy Tensors
- P-2391 On an Invariant Characterization of Momentum-energy Tensors for Generalized Media
- P-2411 Differential Compatibility Conditions on the Momentum-energy Tensor and Necessary Conditions for the Existence of Solutions to the Einstein Field Equations
- P-2545-1 The Null Set of the Euler-Lagrange Operator

EDINGER, J. G.

- P-1019 Dispersion in the Upper Atmosphere

EDMUNDSON, H. P.

- RM-1744 The Distribution of Radial Error and Its Statistical Application in War Gaming
- RM-1820 The Goodness-of-fit Statistics of Kolmogorov and Smirnov
- RM-1905 The Moments of Two Limiting Distributions of Kolmogorov
- RM-1958 The Moments of Two Distribution-free Statistics of Smirnov
- ★ RM-2060 Studies in Machine Translation—2: Research Methodology
- RM-2061 Studies in Machine Translation—5: Manual for Key punching Russian Scientific Text
- RM-2063 Studies in Machine Translation—1: Survey and Critique
- RM-2064 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats

★ Indicates publications which are out of print.

- RM-2069 Studies in Machine Translation—9: Bibliography of Russian Scientific Articles
- P-982 Bounds on the Expectation of a Convex Function of a Random Variable
- P-1251 Studies in Machine Translation—2: Research Methodology
- P-1328 Linguistic Analysis in Machine Translation Research
- P-1352 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- P-1473 The Distribution of Radial Error and Its Statistical Application in War Gaming
- P-1474 The Goodness-of-fit Statistics of Kolmogorov and Smirnov
- P-1475 The Moments of Two Limiting Distributions of Kolmogorov
- P-1476 The Moments of Two Distribution-free Statistics of Smirnov
- T-45 On a Problem of the Comparison of Two Empirical Distributions
- T-66 Asymptotic Expansions for the Distribution of Maximum Deviations in the Bernoulli Scheme
- T-67 On a Local Limit Theorem for Inhomogeneous Markov Chains
- T-75 An Asymptotic Expansion for Inhomogeneous Markov Chains

EDWARDS, T. I.

- T-32 The Brush-off Is Called "New Look"

EISEMANN, D. M.

- RM-2327 Military Supersonic Transports
- P-1370 Manufacturers' Inventory Cycles and Monetary Policy
- P-1492 The Progress-curve Computer

EISENBERG, E.

- P-1363 Aggregation of Utility Functions
- P-1379 Consensus of Subjective Probabilities: The Pari-mutuel Method

ELDRIDGE, F. R., JR.

- P-1657 Protection of Communications and Electronic Systems

ELLIS, D. O.

- RM-1548 The Number of Distinct Cuts in a Network
- P-698 The Topology of Finitary Approximation
- P-712 A Theorem on Description Adequacy
- P-783 An Abstract Setting for the Notion of Dynamic Programming

ELLIS, J. W., JR.

- RM-453 Performance Effects of Double Refueling
- P-1840 The Contextual Study: A Structured Approach to the Study of Political and Military Aspects of Limited War

ELLIS, T. O.

- P-1277 A Command Structure for Complex Information Processing

ELLSBERG, D.

- P-2173 Risk, Ambiguity, and the Savage Axioms
- P-2183 The Crude Analysis of Strategic Choices

ELSWICK, W. R.

- RM-1677 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Response and Scaling of Floating Roof Tanks
- RM-2410 The Vulnerability of Hypothetical Rail Transport for a Mobile Ballistic Missile System
- RM-2500 An Evaluation of the Human Retinal Burn Problem Arising from Atomic Detonations
- RM-2660 Pressure Response within an Enclosure Subject to a Blast Wave
- P-1676 The Cooling Problems of Chemical and Nuclear Power Plant Application to a Class of Large Shelters

EMERSON, R. C.

- P-294 Applications of the Kac-Siebert Method for Finding Output Probability Densities for Receivers with Square Law Detectors
- P-338 On Maximizing an Integral with a Side Condition

EMMONS, W. H.

- ★ RM-1222 Considerations for Research in a Sleep-learning Program
- RM-1442 Responses to Material Presented during Various Levels of Sleep
- RM-1444 The Nonrecall of Material Presented during Sleep
- P-447 Experiments on "The Cortical Correlate of Pattern Vision"
- P-534 A Critical Review of the "Learn-While-You-Sleep" Studies
- P-565 Considerations for Research in a Sleep-learning Program
- P-618 Responses to Material Presented during Various Levels of Sleep
- P-619 The Nonrecall of Material Presented during Sleep
- P-655 The EEG, Consciousness, and Sleep
- P-795 A Simple Model for the Production of the Normal Electroencephalogram

ENKE, S.

- ★ RM-299 The Economic Sinews of Modern War: Physical Limitations on War Production
- RM-1190 Some Characteristics of Manufacturers' Parts Numbers Now Included in Air Force Catalogs
- RM-1508 Some Implications of "Weapons System Support" by AMC
- RM-1993 Logistics Laboratory Problem I after Two (Simulated) Years
- P-117 International Commodity Equilibrium: Solution by Electric Analogue
- P-462 Some Economic Aspects of Fissionable Material
- ★ P-758 Logistics and RAND: The First Two Years
- P-1154 Do Disparities between Real and Money Prices Modify Traditional Arguments for Freer Trade?
- P-1179 An Economist Looks at Air Force Logistics
- P-1323 Controlling Consumers during Future Wars and Their Aftermaths
- P-1343 Use of a Simulation Laboratory To Study the Organization and Effectiveness of Air Force Logistics
- P-1366 Interservice Supply Management within the Defense Department
- P-1368 On the Economic Management of Large Organizations: A Case Study in Military Logistics Involving Laboratory Simulation
- P-1616 The Federation of Rhodesia and Nyasaland: A Case Study in Economic Development
- P-1649 The Gains to India from Population Control: Some Money Measures and Incentive Schemes
- P-1721 Preliminary Thoughts about India's Third Five-year Plan
- P-1747 Seven Fallacies about Central Africa
- P-2118 Capital Intensity as a Mitigation of Inferior Labor: A General Theorem
- P-2226 Production Functions and Capital Depreciation

ENTHOVEN, A. C.

- P-1051 The Economics of Navy Pay
- P-1100 The Mathematics of Military Pay
- P-1186 Supply and Demand and Military Pay
- P-1567 Money and the Interest Rate in a Neoclassical World
- P-1640 Defense Planning and Organization
- P-1833 The Simple Mathematics of Maximization
- P-1847 Quasi-concave Programming

ESTRIN, G.

- P-1989 A Digital Simulation of an Aided Adaptive Character Reading Machine
- P-1990 An Aided Adaptive Character Reader for Machine Translation of Languages

EUROPA ARCHIV, FRANKFURT A. M.

- RM-926 German Youth and Its Attitude toward a German Defense Contribution
- RM-927 The Attitude of the Christian Churches toward a German Defense Contribution
- RM-928 German Veterans' Organizations and the Defense Contribution
- RM-929 German Labor Unions and the Question of German Participation in European Defense

★ Indicates publications which are out of print.

RM-930 The Ideological Groups in Germany and Their Attitude toward the Defense Contribution

FAGG, D. R.

P-1275 What the Factory Worker Knows about His Factory

FAINSOD, M.

P-843-RC Censorship in the USSR: A Documented Record

FAIRBROTHER, E. M.

P-2409 An Extension to VLF Reflection Coefficients

FAN, K.

RM-2883-PR On Systems of Linear Inequalities in Hermitian Matrix Variables

P-588 Fully Convex Normed Linear Spaces

FARMER, J.

P-2495 Decisions, Communication, and Organization

FEIGENBAUM, E. A.

RM-2799-PR Soviet Cybernetics and Computer Sciences, 1960

P-1817 An Information Processing Theory of Verbal Learning

P-2235 The Simulation of Verbal Learning Behavior

P-2311 Forgetting in an Association Memory

P-2358 Performance of a Reading Task by an Elementary Perceiving and Memorizing Program

P-2375 A Theory of the Serial Position Effect

FELDMAN, N. E.

P-2314 Aspects of Synchronous Communication Satellites

FERGUSON, A. R.

RM-1369 Notes on Linear Programming—Part XVI: The Problem of Routing Aircraft—A Mathematical Solution

RM-1817 Air Force Logistics: Some Recent Developments

RM-1833 Notes on Linear Programming—Part XXXVI: The Allocation of Aircraft to Routes—An Example of Linear Programming under Uncertain Demand

RM-1962 Stockage Policies for Medium- and Low-cost Parts

P-561 The Problem of Routing Aircraft: A Mathematical Solution

P-727 The Allocation of Aircraft to Routes: An Example of Linear Programming under Uncertain Demand

P-855 Air Force Logistics: Some Recent Developments

P-1262 Air Force Logistics: From Research to Policy

P-1347 A Marginal Cost Function for Highway Construction and Operation

P-2140 Mechanics of Some Limited Disarmament Measures: A Simple Economic Treatment

FERRELL, R. A.

RM-1412-AEC Effect of Correlations on the Equation of State of an Electron Gas

RM-1865-AEC The Characteristic Energy Loss of Electrons Passing through Metal Foils—II: Dispersion Relation and Short Wave Length Cutoff for Plasma Oscillations

RM-2271 Correlation Energy of a Degenerate Electron Gas

P-1002-AEC The Characteristic Energy Loss of Electrons Passing through Metal Foils—II: Dispersion Relation and Short Wave Length Cutoff for Plasma Oscillations

P-1482 On the Possibility of an Energy Gap in the Spectrum of a Degenerate Fermi Liquid

P-1523 Correlation Energy of a Degenerate Electron Gas

FIELD, E. C., JR.

P-2249 VLF Ionospheric Reflection Coefficients: Derivation from Impedance Concepts and Values for Some Model Ionospheres

P-2409 An Extension to VLF Reflection Coefficients

FIRSTMAN, S. I.

- R-358 Automatic Checkout Equipment: Employment and Design Considerations
RM-1985 A Vulnerability Model for Weapon Sites with Interdependent Elements
RM-2149 Monte Carlo Models for Estimating Reliability: An Exploratory Analysis
RM-2471 A Preliminary-design Aid for Studying Component Weight Assignments in Ballistic-missile Payloads
RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
RM-2514 Search Rules for Automatic Fault Location
RM-2685 Standardization of Automatic Test and Checkout Equipment: A Preliminary Discussion
RM-2735-PR Operational Criteria for the Design of Missile-readiness Testing Programs and Equipment
RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
RM-2835-PR Operational and Human Factors in Planning Automated Man-Machine Checkout Systems
P-1384 A Vulnerability Model for Weapon Sites with Interdependent Elements
P-1521 Reliability Estimating by the Use of Random Sampling Simulation
P-1638 The Application of Random Sampling Simulation to Reliability Estimating
P-1678 An Approximating Algorithm for an Optimum Aim-points Problem
P-1839 Ballistic-missile Payload Allocation
P-1853 The Use of Reliability Estimates in the Design of Missile Prelaunch Checkout Equipment
P-1857 Optimum Search Routines for Automatic Fault Location
P-1867 How Much Automaticity for Checkout Equipment
P-1997 Optimizing a Prelaunch Checkout
P-2112 Operational Design Criteria for Missile Ground Systems: Readiness Testing
P-2267 The Role of Operational Analyses in Planning an Effective Missile Ground System
P-2319 Some Limitations of Automatic Test Equipment
P-2538 A Game Theoretic Approach to Space Vehicle Prelaunch Activities Scheduling

FISHER, G. H.

- RM-954 On Predicting a Combination of Outputs and Final Demands by Input-Output
RM-1199-1 Distribution of Indirect Costs: A Method of Allocating the Cost of Air Force Interdependent Support Activities to Mission Activities
RM-2975-PR Military Systems Cost Analysis: A Summary Lecture for the AFSC Cost Analysis Course
P-511 Allocation of Indirect Costs
P-694 The Role of Management Tools in Making Military Decisions
P-823 Weapon-system Cost Analysis
P-1883 Comments on Some Aspects of Corporate Planning in the Defense Industry

FISHER, L.

- RM-1962 Stockage Policies for Medium- and Low-cost Parts

FLEMING, W. H.

- RM-737 Note on Games over a Function Space with Homogeneous Kernels
RM-745 On Weak Convergence of Strategies in Certain Games over a Function Space
RM-810 Expected Damage from One Bomb to a Circular Ring
RM-814 Minmax Theorem for a Class of Games over a Function Space
RM-897 Reduction of Certain Games over Function Space
RM-1409 On Maximizing an Inner Product
RM-1430 A Resource Allocation Problem in Continuous Form
RM-1501 Discrete Approximations to Some Continuous Dynamic Programming Processes
RM-1526 Discrete Approximations to Some Differential Games
RM-1529 Relative Maxima in Variational Problems with Inequality Constraints
★ P-262 A Simple Type of Game over Function Space, Convex for the Minimizing Player
P-405 On a Class of Games over Function Space and Related Variational Problems

★ Indicates publications which are out of print.

- P-639 Variational Problems with Constraints
- P-717 On Differential Games with Integral Payoff
- P-2033 The Convergence Problem for Differential Games

FLOOD, M. M.

- RM-267 Illustrative Example of Application of Koopmans' Transportation Theory to Scheduling Military Tanker Fleet
- RM-709 Report of a Seminar on Organization Science
- RM-780 A Preference Experiment
- RM-789-1 Some Experimental Games
- RM-913 Aerial Bombing Tactics: General Considerations (A World War II Study)
- RM-953 Some Group Interaction Models
- P-213 On the Hitchcock Distribution Problem
- P-256 A Preference Experiment
- P-258 A Preference Experiment
- P-263 A Preference Experiment
- P-312 Testing Organization Theories
- P-345 The Influence of Environmental Nonstationarity in a Sequential Decision-making Experiment
- P-346 On Game-learning Theory and Some Decision-making Experiments
- P-353 On Stochastic Learning Theory

FONG, J. K. T.

- T-141 On Problems Concerning the Legal Status of Outer Space

FORD, L. R., JR.

- RM-1400 Notes on Linear Programming—Part XX: Maximal Flow through a Network
- RM-1604 Notes on Linear Programming—Part XXIX: A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem
- RM-1709 Notes on Linear Programming—Part XXXI: A Primal-Dual Algorithm
- RM-1736 Notes on Linear Programming—Part XXXII: Solving the Transportation Problem
- RM-1798 Notes on Linear Programming—Part XXXIV: A Primal-Dual Algorithm for the Capacitated Hitchcock Problem
- RM-1860 Solution of a Ranking Problem from Binary Comparisons
- RM-1977 Notes on Linear Programming—Part XL: Network Flow and Systems of Representatives
- RM-1981 Notes on Linear Programming—Part XLI: Constructing Maximal Dynamic Flows from Static Flows
- P-605 Maximal Flow through a Network
- P-743 A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem
- P-778 A Primal-Dual Algorithm
- P-827 A Primal-Dual Algorithm for the Capacitated Hitchcock Problem
- P-877 Solution of a Ranking Problem from Binary Comparisons
- P-895 Solving the Transportation Problem
- P-923 Network Flow Theory
- P-967 Constructing Maximal Dynamic Flows from Static Flows
- P-990 Network Flow and Systems of Representatives
- P-1070 A Cyclic Arrangement of n -Tuples
- P-1079 Construction of Maximal Dynamic Flows in Networks
- P-1114 A Suggested Computation for Maximal Multi-commodity Network Flows
- P-1215 A Tournament Problem

FORT, D. M.

- RM-1801 A Linear Programming Model of the Gaseous Diffusion Isotope-separation Process
- RM-2062 Experimental Design and Evaluation of an F-86H Flyaway Kit
- P-1231 A Linear Programming Model of the Gaseous diffusion Isotope-separation Process
- P-1621-RC Proposal for a "Smog Tax"
- P-1899 The Separation of Uranium Isotopes by Gaseous Diffusion: A Linear-programming Model

FORT, T. M.

P-1260 On Convergent Perturbation Expansions

FREDMAN, H. B.

RM-2561 Communist Strategy in Laos

P-2330 Laos in Strategic Prospective

FEIMER, M.

P-2334 A New Approach to the Duality Theory of Mathematical Programming

FRICK, R. H.

R-136 Effect of Missile Dynamics on Flight Path

RM-1359 Computation of Radiation Level in the Vicinity of a Distribution of Contaminating Material

RM-1641 Graphical Determination of Ballistic Trajectories: Through Outer Space with Compass and Straightedge

FROMME, W. M.

RM-453 Performance Effects of Double Refueling

FRYE, W. E.

RM-323 On the Expected Damage from Single Bomb Drops

P-135 On the Accuracy of the Long-range Ballistic Rocket

T-24 The Perturbation of Pendulum and Gyroscopic Instruments by Acceleration of the Vehicle

FULKERSON, D. R.

RM-1102 A Production-line Assignment Problem

RM-1171 A Tactical Air Game

RM-1328 Notes on Linear Programming—Part XV: Minimizing the Number of Carriers To Meet a Fixed Schedule

RM-1400 Notes on Linear Programming—Part XX: Maximal Flow through a Network

RM-1418 Notes on Linear Programming—Part XXI: On the Max Flow Min Cut Theorem of Networks

RM-1489 Notes on Linear Programming—Part XXVI: Computation of Maximal Flows in Networks

RM-1604 Notes on Linear Programming—Part XXIX: A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem

RM-1709 Notes on Linear Programming—Part XXXI: A Primal-Dual Algorithm

RM-1736 Notes on Linear Programming—Part XXXII: Solving the Transportation Problem

RM-1798 Notes on Linear Programming—Part XXXIV: A Primal-Dual Algorithm for the Capacitated Hitchcock Problem

RM-1977 Notes on Linear Programming—Part XL: Network Flow and Systems of Representatives

RM-1981 Notes on Linear Programming—Part XLI: Constructing Maximal Dynamic Flows from Static Flows

RM-2159 Notes on Linear Programming—Part XLV: A Network-flow Feasibility Theorem and Combinatorial Applications

RM-2178 Notes on Linear Programming—Part XLVI: Bounds on the Primal-Dual Computation for Transportation Problems

RM-2321 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem: Notes on Linear Programming and Extensions—Part 49

RM-2480 On the Equivalence of the Capacity-constrained Transshipment Problem and the Hitchcock Problem: Notes on Linear Programming and Extensions—Part 53

RM-2896-PR Widths and Heights of $(0,1)$ -Matrices

RM-2897-PR Multiplicities and Minimal Widths for $(0,1)$ -Matrices

RM-2898-PR Width Sequences for Special Classes of $(0,1)$ -Matrices

RM-2956-PR An Algorithm for Scaling Matrices: Notes on Linear Programming and Extensions—Part 58

RM-3075-PR Expected Critical Path Lengths in PERT Networks

P-510 Solution of a Large-scale Traveling-salesman Problem

- P-569 Notes on Linear Programming—Part XV: Minimizing the Number of Carriers To Meet a Fixed Schedule
- P-605 Maximal Flow through a Network
- P-677 Computation of Maximal Flows in Networks
- P-681 Note on a Theorem of Dilworth
- P-743 A Simple Algorithm for Finding Maximal Network Flows and an Application to the Hitchcock Problem
- P-778 A Primal-Dual Algorithm
- P-826 On the Max Flow Min Cut Theorem of Networks
- P-827 A Primal-Dual Algorithm for the Capacitated Hitchcock Problem
- P-890 Hitchcock Transportation Problem
- P-895 Solving the Transportation Problem
- P-967 Constructing Maximal Dynamic Flows from Static Flows
- P-990 Network Flow and Systems of Representatives
- P-1063 A Tactical Air Game
- P-1079 Construction of Maximal Dynamic Flows in Networks
- P-1114 A Suggested Computation for Maximal Multi-commodity Network Flows
- P-1188 A Feasibility Criterion for Staircase Transportation Problems and an Application to a Scheduling Problem
- P-1278 A Network Flow Feasibility Theorem and Combinatorial Applications
- P-1281 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem
- P-1315 Comments on "Solution of the Quota Problem by a Successive-reduction Method"
- P-1401 Increasing the Capacity of a Network: The Parametric Budget Problem
- P-1618 Zero-One Matrices with Zero Trace
- P-1792 Widths and Heights of $(0, 1)$ -Matrices
- P-1825 An Out-of-kilter Method for Minimal Cost Flow Problems
- P-1922 Traces, Term Ranks, Widths and Heights
- P-1947 A Network Flow Computation for Project Cost Curves
- P-2272 Multiplicities and Minimal Widths for $(0, 1)$ -Matrices
- P-2363 An Algorithm for Scaling Matrices
- P-2371 Minimal k -Arc-connected Graphs
- T-22 The Theory of Linear Inequalities

GABLER, R. T.

- P-1021 Tracking and Communication for a Moon Rocket
- P-1394 Communications in Space Operations
- P-1481 The Propagation of Errors in Keplerian Orbits

GAIFMAN, H.

- P-2315 Dependency Systems and Phrase Structure Systems

GAINEN, I.

- RM-2086 Baselogs: A Base Logistics Management Game
- RM-2269 The Next Step in Air Force Centralization of Inventory Recordkeeping and Supply-data Processing
- P-1220 Inventory Control: Exploiting the Electronic Data Processor in the Air Force
- P-2195 A Simulation Model for Data System Analysis

GALE, D.

- RM-1542 Information in Games with Finite Resources
- RM-1737 Notes on Linear Programming—Part XXXIII: A Theorem on Flows in Networks
- RM-2152 Notes on Linear Programming—Part XLIV: Transient Flows in Networks
- RM-2368 A Note on Polynomial and Separable Games
- P-798 A Theorem on Flows in Networks
- P-861 Information in Games with Finite Resources
- P-1156 General Equilibrium for Linear Models
- P-1216 A Note on Polynomial and Separable Games

GALE, D.—continued

- P-1264 Transient Flows in Networks
- P-1315 Comments on "Solution of the Quota Problem by a Successive-reduction Method"
- P-1379 Consensus of Subjective Probabilities: The Pari-mutuel Method
- P-1404 On the Rank of a Certain Set of Equations
- P-2240 College Admissions and the Stability of Marriage

GALENSON, W.

- R-257 Labor Productivity in Soviet and American Industry
- RM-1479 Industrial Training in the Soviet Union
- P-126 Russian Labor Productivity Statistics
- P-276 Trends in Soviet Industrial Productivity
- P-729 Industrial Training in the Soviet Union

GARBER, T. B.

- RM-1863-1 An Analysis of the Rotational Motion of a Body during Re-entry
- RM-2527 General Equations of Motion of a Satellite in a Gravitational Gradient Field
- P-723 On the Stability of a Circular Cylinder at Hypersonic Speeds
- P-1407 On the Rotational Motion of a Body Re-entering the Atmosphere
- P-1430 Orientation and Control
- P-1864 Ascent Guidance for a Satellite Rendezvous

GARTHOFF, R. L.

- ★ R-223 Soviet Military Doctrine
- RM-1086 The New Soviet Leadership
- RM-1638 The Role of the Military in Recent Soviet Politics
- P-171 Politburo Images of Stalin
- ★ P-401 The New Soviet Leadership
- P-521 Significant Features of Soviet Military Doctrine
- P-603 Soviet Attitudes toward Modern Air Power
- P-684 The Soviet High Command and General Staff
- P-726 Recent Trends in Soviet Military Policy
- P-937 The Role of the Military in Post-Stalin Soviet Politics
- P-984 The Tragedy of Hungary: A Revolution Won and Lost

GAZLEY, C., JR.

- R-273 Heat-transfer Aspects of the Atmospheric Re-entry of Long-range Ballistic Missiles
- RM-1517 Aerodynamic Research Facilities Required for the Development of Moderate and Long-range Ballistic Missiles
- RM-1524 Transient Heat Conduction in Composite Slabs for a Heat Flux Varying Exponentially with Time
- RM-1735 Surface-protection and Cooling Systems for High-speed Flight
- RM-1844 A Recoverable Scientific Satellite
- RM-1892 Linearized Solution for Heat Addition at the Surface of a Supersonic Airfoil
- RM-2332 Estimated Damage to Space Vehicles by Meteoroids
- RM-2516 A Review of Binary Boundary Layer Characteristics
- RM-2579 Atmospheric Entry of Manned Vehicles
- RM-2852-PR Information on the 1961 Minsk Conference on Heat and Mass Transfer with Phase and Chemical Conversions
- P-829 Surface-protection and Cooling Systems for High-speed Flight
- P-953 Meteoric Interaction with the Atmosphere: Theory of Drag and Heating and Comparison with Observations
- P-955 Deceleration and Heating of a Body Entering a Planetary Atmosphere from Space
- P-958 A Recoverable Scientific Satellite
- P-1119 Recovery of a Circum-lunar Instrument Carrier
- P-1256 Aerodynamics for Space Flight
- P-1322 The Penetration of Planetary Atmospheres
- P-1335 Space-vehicle Environment

★ Indicates publications which are out of print.

- P-1371 General Characteristics of Binary Boundary Layers with Applications to Sublimation Cooling
- P-1729 A Review of Binary Boundary Layer Characteristics
- P-1730 Effect of Molecular Weight on Mass-transfer Cooling in a Laminar Boundary Layer on a Flat Plate
- P-1732 Mass-transfer Cooling in a Turbulent Boundary Layer
- P-1890 Atmospheric Entry of Manned Vehicles
- P-2052 Atmospheric Entry

GAZLEY, J. B.

- RM-2852-PR Information on the 1961 Minsk Conference on Heat and Mass Transfer with Phase and Chemical Conversions
- RM-2930-PR An Adiabatic-isothermal Nozzle
- RM-2931-PR The Structure of a Shock Wave in Air Taking Account of the Kinetics of Chemical Reactions
- RM-2932-PR Concerning a Certain Effect in the Field of Meteor Aerodynamics
- T-138 Sublimation near the Stagnation Point of an Axisymmetrical Blunt Body
- T-140 Calculation of the Heating of Two-layer Plates
- T-142 The Experimental Investigation of the Subsonic Turbulent Boundary Layer on a Plate with Injection
- T-144 Heat and Mass Exchange with a Solid-gas Phase Change on the Surface of a Body
- T-145 On the Analysis of Heat and Mass Transfer in Binary Gas Mixtures

GEISLER, M. A.

- RM-1297 Analysis of the Demand Patterns for B-47 Airframe Parts at Air Base Level
- RM-1300 Predictability of Demand for B-47 Airframe Spare Items
- RM-1357 Confidence Intervals for Poisson Parameters in Logistics Research
- RM-1392 The Cost of Various Base Stocking and Requisitioning Policies for Aircraft Spare Parts
- RM-1402 A Summary of Some Base Supply Activity and Workload Reports
- RM-1413 The Prediction of Demand for Aircraft Spare Parts Using the Method of Conditional Probabilities
- RM-1431 Analysis of Base Stockage Policies
- RM-1490 A Preferred Method for Designing a Flyaway Kit
- RM-1639-1 Research and Development of a New Data-processing System for Air Force Logistics
- RM-1640 The Relation of Aircraft Status Data to the Logistics System
- RM-1786 Relationships between Weapons and Logistics Expenditures
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
- P-611 The Costs of Alternative Air Base Stocking and Requisitioning Policies
- P-748 A Fruitful Application of Static Marginal Analysis
- P-799 The Design of Military Supply Tables for Spare Parts
- P-860 RAND Research on a Data-processing System for the United States Air Force
- P-973 The Logistics Laboratory: Hopes and Plans
- P-991 Some Principles for a Data-processing System in Logistics
- P-1036 Relationships between Weapons and Logistics Expenditures
- P-1234 A First Approach to Logistics System Simulation
- P-1415 A First Experiment in Logistics System Simulation
- P-1555 The Simulation of a Large-scale Military Activity
- P-1615 Communications and Control Requirements in the Air Force Logistics System
- P-1634 Integration of Modeling and Simulation in Organizational Studies
- P-1780 The Use of Man-Machine Simulation in the Design of Control Systems
- P-1808 Simulation Techniques
- P-1823 The Use of Man-Machine Simulation for Support Planning
- P-1868 Logistics Research and Management Science
- P-1945 Development of Man-Machine Simulation Techniques
- P-2086 Man-Machine Simulation Progress
- P-2234 The Use of Manned Simulation in the Weapon System Planning Process

GEISLER, M. A.—continued

- P-2322 The Use of Manned Simulation in the Design of an Operational Control System
- P-2467 Appraisal of Laboratory Simulation Experiments
- P-2502 Some Statistical Properties of Selected Inventory Models
- P-2517 A Brief Review of Inventory Theory
- P-2543 A Statistical Approach to Simulation

GELINAS, R. W.

- P-1585 Masers and Irasers
- P-1697 A Broad Look at the Performance of Infrared Detectors
- P-1844 Infrared Detection by Ideal Irasers and Narrow Band Counters

GELL-MANN, M.

- RM-1802-AEC The Correlation Energy of an Electron Gas at High Density
- RM-1823-AEC The Specific Heat of a Degenerate Electron Gas at High Density
- P-985-AEC The Correlation Energy of an Electron Gas at High Density
- P-988-AEC The Specific Heat of a Degenerate Electron Gas at High Density

GENDLER, S. L.

- ★ RA-15027 Satellite Rocket Powerplant

GENENSKY, S. M.

- RM-2617 Geological Covering Materials for Deep Underground Installations
- RM-2754 Glossary of Terms on National Security
- P-1484 A General Theorem Concerning the Stability of a Particular Non-Newtonian Fluid
- P-1681 Some Comments on the Wave Propagation Study Group
- P-2346 Glossary of Terms on National Security

GENOUD, R. H.

- P-1697 A Broad Look at the Performance of Infrared Detectors

GEORGE, A. L.

- P-217 Methodology for Communications Research
- P-302 Emotional Stress and Air War
- P-522 U.S. Reaction to North Korean Aggression
- P-616 The Scientific Status of Propaganda Analysis
- P-617 Qualitative and Quantitative Procedures in Content Analysis
- P-779 Prediction of Political Action by Means of Propaganda Analysis
- P-1572 Quantitative and Qualitative Approaches to Content Analysis

GERMOND, H. H.

- RM-40 A "Semi-Poisson" Distribution
- RM-92 Forecast of Production Time
- RM-97 Hermite Polynomials of Imaginary Argument
- RM-123 An Integral Arising in Vulnerability Studies
- RM-133 Expected Overlap
- RM-134 An Approximate Solution for a Coverage Problem
- RM-145 Target Coverage
- RM-151 Empirical Analysis: Exponential Series
- RM-163 Area Coverage with Ordinary Bombs
- RM-181 An Upper Limit to Cycle-length in a Sequence of Digit Groups
- RM-191 Expected Coverage When All Bombs Are Aimed at the Center of the Target
- RM-194 Empirical Analysis: Power Series
- RM-242 Successive Approximation
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-252 Composite Targets: n Identical Elements
- RM-274 Determination of Expected Coverage and of Expected Damage: Single Bomb of Large Lethal Area
- RM-306 Expected Coverage with Conventional Bombs When Rectangular Patterns Are Employed against Rectangular Targets

★ Indicates publications which are out of print.

- RM-309 A Circular Probability Grid
- RM-330 The Circular Coverage Function
- P-94 Integral of the Gaussian Distribution over an Offset Ellipse

GERSCHENKRON, A.

- ★ R-197 A Dollar Index of Soviet Machinery Output, 1927–28 to 1937
- RM-804 A Dollar Index of Soviet Petroleum Output, 1927–28 to 1937
- RM-1042 A Dollar Index of Soviet Coal Output, 1927/28–1937
- RM-1055 A Dollar Index of Soviet Iron and Steel Output, 1927/28–1937
- RM-1282 A Dollar Index of Soviet Electric-power Output
- P-560 Soviet Heavy Industry: A Dollar Index of Output, 1927/28–1937

GIAMBONI, L. A.

- RM-1338 Analytic Formulation of a Theater Air-Ground Warfare System (1953 Techniques)
- P-1409 Lunar Rays: Their Formation and Age

GILINSKY, V.

- RM-3050-PR Collision Damping of Plasma Oscillations

GILLMAN, L.

- P-235 A Game over Function Space

GILMORE, F. R.

- RM-1543 Equilibrium Composition and Thermodynamic Properties of Air to 24,000°K
- RM-1551 Approximate Values for the Continuous Absorption Coefficient of Air between 2 and 600 Volts
- RM-1650 Approximate Thermodynamic Properties of Compressed Hydrogen Gas from 5000° to 12,000°K
- RM-1743 A Table of the Planck Radiation Function and Its Integral
- RM-2328 Additional Values for the Equilibrium Composition and Thermodynamic Properties of Air
- RM-2367-AEC Graphs of X-ray Absorption Coefficients for Fourteen Substances
- P-2160 Positive Ions in the Lower D Region

GILVARRY, J. J.

- R-144 Theory of Blind Navigation by Dynamical Measurements
- ★ R-154 Theory of Errors in Automatic Navigation with Integrating Accelerometer Systems
- RM-1420-AEC Solutions of the Temperature-perturbed Thomas-Fermi Equation
- RM-1446-AEC The Lindemann and Grüneisen Laws
- RM-1457-AEC Grüneisen's Law and the Fusion Curve at High Pressure
- RM-1496-AEC The Equation of the Fusion Curve
- RM-1556-AEC The Grüneisen Parameter for an Einstein Solid and under Finite Strain
- RM-1704 Amplitudes of Thermal Vibration at Fusion
- RM-1793-AEC Thermodynamic Properties of Mixtures on the Statistical Model
- P-121 Theory of Blind Navigation by Dynamical Measurements
- ★ P-138 A Note on Cullwick's Tentative Explanation of the Observed Masses of Mesons
- ★ P-244 Linear Approximations in a Class of Nonlinear Vector Differential Equations
- ★ P-343 Relativity Precession of Minor Planets
- P-474-AEC Thermodynamics of the Thomas-Fermi Atom at Low Temperatures
- P-500 A Note on the Relativistic Thomas-Fermi Atom Model
- P-520-AEC Solution of the Temperature-perturbed Thomas-Fermi Equation
- P-591-AEC Solutions of the Temperature-perturbed Thomas-Fermi Equation
- P-644-AEC The Lindemann and Grüneisen Laws
- P-650-AEC Grüneisen's Law and the Fusion Curve at High Pressure
- P-682-AEC The Equation of the Fusion Curve
- P-747-AEC The Grüneisen Parameter for an Einstein Solid and under Finite Strain
- P-785 The Impact Theory of the Origin of Lunar Craters
- P-801 Application of the Baldwin Crater Relation to the Scaling of Explosion Craters
- P-836 The Impact of Large Meteorites

★ Indicates publications which are out of print.

GILVARRY, J. J.—continued

- P-840 Properties of the Shock Transition at Low Temperature
- P-854 Amplitudes of Thermal Vibration at Fusion
- P-875 Temperatures in the Earth's Interior
- P-894 Variation of the Amplitude of Thermal Vibration on the Fusion Curve
- P-927-AEC Thermodynamic Properties of Mixtures on the Statistical Model

GIRSHICK, M. A.

- RM-206 A Generalization of the Silent Duel, Two Opponents, One Bullet Each, Arbitrary Accuracy
- RM-219 A Loud Duel with Equal Accuracy Where Each Duelist Has Only a Probability of Possessing a Bullet
- RAOP-17 Sampling Inspection Plans for Continuous Production
- RAOP-37 Bayes and Minimax Solutions of Sequential Decision Problems
- P-93 The Prediction of Social and Technological Events

GIST, W. B.

- RM-1205 Approximate Methods for Determining the Performance of Gas Turbine Engines at Off-design Conditions

GLICKSBERG, I. L.

- R-313 Some Aspects of the Mathematical Theory of Control Processes
 - RM-433 Best Strategies for Continuous Games with a Continuous Payoff
 - RM-435 Games Played over Nonconvex Sets of Mixed Strategies
 - RM-474 Noisy Duel, One Bullet Each, with Simultaneous Fire and Unequal Worths
 - RM-478 Minimax Theorem for Upper and Lower Semicontinuous Payoffs
 - RM-491 Notes on the Game with Rational Payoff
 - RM-499 On Measurable Functions K Which Satisfy $K(x + y) = \sum_{v=1}^n \varphi_v(x) \psi_v(y)$
 - RM-501 A Class of Games with Unique Density Function Solutions
 - RM-510 Continuous Games with Given Strategies
 - RM-538 A Class of Games with Unique Solutions
 - RM-549 The Pathological Nature of Certain Games with Rational Payoff
 - RM-568 The Pathological Nature of Certain Games with Rational Payoff—II
 - RM-593 Density of Games with Unique Solutions
 - RM-610 Moments of the Distribution of Outcomes of a Game
 - RM-611 A Game with Respective Optimal Spectra of Cardinality c and 1
 - RM-620 Continuous Games with Given Unique Solutions
 - RM-655 Games Concave on Each Side of the Unit Square Diagonal
 - ★ RM-688 A Bibliography of the Theory and Application of Differential-Difference, Renewal, and Related Functional Equations
 - RM-889 Optimal Sets for Games over the Square
 - RM-901 Solution Sets for Games on the Square
 - ★ RM-972 On Some Variational Problems Occurring in the Theory of Dynamic Programming—II
 - ★ RM-973 On Some Variational Problems Occurring in the Theory of Dynamic Programming—III
 - ★ RM-978 On Some Variational Problems Occurring in the Theory of Dynamic Programming—IV
 - ★ RM-980 On Some Variational Problems Occurring in the Theory of Dynamic Programming—V
 - ★ RM-994 On Some Variational Problems Occurring in the Theory of Dynamic Programming—VI
 - RM-1102 A Production-line Assignment Problem
 - RM-1318 On the Minimization of $\int_0^T |1 - x(t)| dt$
 - P-193 A Further Generalization of the Kakutani Fixed-point Theorem, with Applications to Nash Equilibrium Points
 - ★ P-341 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- ★ Indicates publications which are out of print.

- P-379 A Derivative Test for Finite Solutions of Games
- P-380 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-491 The Theory of Dynamic Programming as Applied to a Smoothing Problem
- P-552 On the "Bang-Bang" Control Problem
- P-572 On the Optimal Inventory Equation
- P-580 On the Optimal Inventory Equation
- P-588 Fully Convex Normed Linear Spaces
- P-594 Notes on Matrix Theory—VI
- P-636 Some Nonclassical Problems in the Calculus of Variations
- P-678 Čech Compactifications of Products

GLIKSMAN, J. G.

- ★ RM-1756 Recent Trends in Soviet Labor Policy
- RM-2494 The Control of Industrial Labor in the Soviet Union
- P-1048 Soviet Labor and the Question of Productivity
- P-1336 The Russian Urban Worker: From Serf to Proletarian

GLUSS, B.

- RM-2514 Search Rules for Automatic Fault Location
- P-1857 Optimum Search Routines for Automatic Fault Location
- P-2145 On Various Versions of the Defective Coin Problem

GOLDHAMER, H.

- ★ R-157 The Frequency of Mental Disease: Long-term Trends and Present Status
- RM-388 Human Factors in Systems Analysis
- P-70 The Conditional Expectancy of Mental Disease
- P-311 An Application of Markov Processes to the Study of the Epidemiology of Mental Disease
- P-1679-RC Some Observations on Political Gaming

GOLDMAN, T. A.

- RM-1858 Relationships between Program Elements and System Demand for Airframe Spare Parts
- RM-2088 A Priori Demand Prediction: A Case Study of B-52 Airframe Parts
- P-1010 Continuous Production and Emergent Demand
- P-1181 Efficient Transportation and Industrial Location

GOLDSEN, J. M.

- R-362-RC International Political Implications of Activities in Outer Space: A Report of a Conference, October 22–23, 1959
- P-1435 Some Political Implications of the Space Age
- P-1688 Outer Space and the International Scene

GOLDSMITH, M.

- RM-1718 The Optimization of Nozzle Area Ratio for Rockets Operating in a Vacuum
- RM-1796 On the Optimization of Two-stage Rockets
- P-1004 On the Optimization of Two-stage Rockets
- P-1112 The Optimization of Nozzle Area Ratio for Rockets Operating in a Vacuum
- P-1542 Suitability of Solid and Liquid Rocket Engines for Placing Manned Satellites on Orbit
- P-1558 A Layman's Review of Propulsion and Propellants for Space Flight
- P-1651 Augmentation of Nuclear-rocket Specific Impulse through Mechanical-Electrical Means
- P-2095 Liquid Propellant Rockets: 1960
- T-60 The Theory of Mixture Preparation in Continuously Burning Combustion Chambers (Parts I and II)

GOLDSTEIN, J. R.

- P-1042 Scientific Aids to Decisionmaking: A Perspective
- P-2236-1 RAND: The History, Operations, and Goals of a Nonprofit Corporation

GOLLOS, W. W.

- RM-1129 Boundary-layer Drag for Nonsmooth Surfaces

★ Indicates publications which are out of print.

GOMORY, R. E.

- RM-2597 An Algorithm for the Mixed Integer Problem: Notes on Linear Programming and Extensions—Part 54
P-1885 An Algorithm for the Mixed-integer Problem

GOMPF, G. E.

- RM-239 Air Battle Theory: Statistical Survival Analysis for Close-controlled Interceptors versus Bombers
RM-240 Basic Survival-probability Expressions for Air Combat Models
RM-863 The Generalized Outcome of a Class of Machine-gun Duels

GOODMAN, L. A.

- P-1806-1 Parameter-free and Nonparametric Tolerance Limits: The Exponential Case

GORDON, G.

- RM-2323 A Generalized Formulation for Inertial Navigators and Gravitationally Stabilized Satellites
T-85-PR The Determination of Orbits

GORE, L. A.

- R-258-RC A Brief Survey of the Technology and Economics of Water Supply
RM-1151 Response of Drag Type Structure to Blast
RM-1677 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Response and Scaling of Floating Roof Tanks
RM-1680 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Motion of Liquid Surface in an Open Rectangular Tank

GORHAM, W.

- RM-2144 Factors Affecting the Experience Composition of Airmen in USAF Job Categories: A Mathematical Approach
RM-2587 An Application of a Network Flow Model to Personnel Planning
P-1193 A Concept of Stability in Manpower Planning
P-1942 Some Analytical Techniques for Personnel Planning

GOURÉ, L.

- RM-788 Political Vulnerability of Moscow: A Case Study of the October, 1941, Attack
RM-2075 Soviet Administrative Controls during the Siege of Leningrad
P-1351 The Political Position of the Soviet Army since Stalin
P-1887 Soviet Civil Defense
P-2340 Civil Defense Training in Russia
P-2415 Soviet Civil Defense
P-2425 Soviet Views on the Role of Civil Defense
P-2438 How Well Do We Know the Soviet Union?
P-2554 The Soviet Civil Defense Program
T-82 Soviet Commentary on the Doctrine of Limited Nuclear Wars
T-83 Anti-atomic Defense in the Soviet Air Force
T-84 Some Soviet Views on Air Strategy
T-116 "The Airfield Continues to Operate"

GREEN, A. H.

- RAOP-23 The Design of Constant-volume Missile Fuselages Having Minimum Drag at Supersonic Speeds

GREEN, J. M.

- RM-2223-AEC The Free-free Gaunt Factor in an Ionized Medium
RM-2447-AEC The Emissive Power of Ionized Hydrogen Gas
RM-2580-AEC Fermi-Dirac Averages of the Free-free Hydrogenic Gaunt Factor
RM-2798-AEC The Strength of Underground Cavities of Spherical and Spheroidal Geometry

GREENE, T. E.

- P-1840 The Contextual Study: A Structured Approach to the Study of Political and Military Aspects of Limited War
P-2117 The "Contextual Study" Method as a Device for Studying Limited-war Strategies

GREENFIELD, S. M.

- R-365 Inquiry into the Feasibility of Weather Reconnaissance from a Satellite Vehicle
- RM-1153-AEC Ionization of Radioactive Particles in the Free Air
- RM-1676-AEC A Catalog of Fallout Patterns
- RM-1969 Radioactive Contamination from a Multibomb Campaign
- P-701-AEC Ionization of Radioactive Particles in the Free Air
- P-733 Scientific Use of an Artificial Satellite
- P-761 Synoptic Weather Observations from Extreme Altitudes
- P-822-AEC Close-in Fallout
- P-883-AEC Rain Scavenging of Radioactive Particulate Matter from the Atmosphere
- P-1402 Satellite Weather Reconnaissance
- P-1535 On Lunar and Planetary Experiments
- P-1735 Spectral Measurements of Atmospheric Radiation from a Meteorological Satellite

GREENWALD, I. D.

- RM-644 Extracting Roots of Polynomial Equations
- P-719 Conclusions after Using the PACT-1 Advanced Coding Technique
- P-1273 Programming and Modification in the SHARE 709 System
- P-1752 A Technique for Handling Macro Instructions

GREIFINGER, C.

- P-1875 Effect of a Transverse Magnetic Field on the "Escape Speed" of a Conducting Fluid
- P-2008 One-dimensional Expansion of a Finite Mass of Gas into Vacuum
- P-2141 Similarity Solution for Cylindrical Magnetohydrodynamic Shock Waves Produced by a Line Current Which Increases Linearly with Time
- P-2293 Magnetically Driven Shock Waves
- P-2318 Analytic Methods and Approximations of MHD Problems

GREIFINGER, P. H.

- RM-1794 Transport Coefficients of Dissociating and Slightly Ionizing Air
- RM-2244 Heat Transfer in a Dissociating Gas
- P-1794 Induced Oscillations in a Rarefied Plasma in a Magnetic Field
- P-2075 Charge Density in the Wake of a Point Charge Traveling in a Plasma

GRIGGS, D. T.

- RM-2456-AEC Probing the Earth with Nuclear Explosions
- RM-2696-AEC Power Recovery from the Kilauea Iki Lava Pool
- P-2111-AEC Probing the Earth with Nuclear Explosions

GRIMMINGER, G.

- ★ RA-15021 Flight Mechanics of a Satellite Rocket
- ★ RA-15022 Aerodynamics, Gas Dynamics, and Heat Transfer Problems of a Satellite Rocket
- ★ RAOP-1 Analysis and Performance of the Ramjet Engine
- RAOP-18 Probability That a Meteorite Will Hit or Penetrate a Body Situated in the Vicinity of the Earth
- P-87 Lift on Inclined Bodies of Revolution in Hypersonic Flow

GROSS, J. F.

- RM-2516 A Review of Binary Boundary Layer Characteristics
- P-1329 Review and Discussion of the Problem of Binary Laminar Boundary Layers—Part I: Stability Considerations
- P-1371 General Characteristics of Binary Boundary Layers with Applications to Sublimation Cooling
- P-1729 A Review of Binary Boundary Layer Characteristics
- P-1730 Effect of Molecular Weight on Mass-transfer Cooling in a Laminar Boundary Layer on a Flat Plate
- P-1732 Mass-transfer Cooling in a Turbulent Boundary Layer
- P-2046 On the Problem of Ballistic Missile Defense
- T-89 Some Results Taken from Observations of the First Russian Earth Satellites

★ Indicates publications which are out of print.

GROSS, J. F.—continued

- T-90 Unified Dynamics and Thermodynamics of a Thermal Plasma
T-96 Mollier Enthalpy-Entropy Charts for High-temperature Plasmas
T-99 Equilibria in a Thermal Plasma Composed of $C + H_2$ and $C + 2H_2$ in a Temperature Range from 5000°K to 50,000°K at a Total Pressure of 1 Bar
T-100 Equilibria in $C + H_2$ and $C + 2H_2$ Systems at Temperatures between 1000°K and 6000°K

GROSS, O. A.

- R-313 Some Aspects of the Mathematical Theory of Control Processes
RM-59 Representation by Sums of Separable Functions
RM-83 Representation by Sums of Separable Functions in n Dimensions
RM-86 A Note on the Sums of Powers of the Roots of a Polynomial
RM-98 Note on a Functional Form for Polynomials
RM-103 On the Number of Preference Arrangements of n Objects
RM-176 Some Notes on the Slide-rule Problem
RM-183 A Slide-rule Inequality
RM-320 Local Defense of Targets of Equal Value: Extension of Results
RM-329 Local Defense of Targets of Equal Value: Completion of Results
RM-359 n Targets of Differing Vulnerability with Attack Stronger than Defense
RM-408 A Continuous Colonel Blotto Game
RM-424 The Symmetric Blotto Game
RM-446 On the Number of Eigenvalues of a Certain Symmetric Kernel
RM-450 On Functions of the Form $\sum_{i=1}^n \varphi_i(x)\psi_i(y)$
RM-491 Notes on the Game with Rational Payoff
RM-499 On Measurable Functions K Which Satisfy $K(x+y) = \sum_{v=1}^n \varphi_v(x)\psi_v(y)$
RM-501 A Class of Games with Unique Density Function Solutions
RM-510 Continuous Games with Given Strategies
RM-538 A Class of Games with Unique Solutions
RM-549 The Pathological Nature of Certain Games with Rational Payoff
RM-568 The Pathological Nature of Certain Games with Rational Payoff—II
RM-593 Density of Games with Unique Solutions
RM-610 Moments of the Distribution of Outcomes of a Game
RM-611 A Game with Respective Optimal Spectra of Cardinality c and 1
RM-620 Continuous Games with Given Unique Solutions
RM-655 Games Concave on Each Side of the Unit Square Diagonal
RM-705 A Game Value Characterization of Algebraic Numbers
RM-706 A Note on Payoffs Which Vanish Almost Everywhere
RM-718 An Infinite-dimensional Extension of a Symmetric Blotto Game
RM-752 A Second Note on Payoffs Which Vanish Almost Everywhere
RM-859 Some Functional Equations Related to Dynamic Programming Problems Involving Noncommutative Operations
RM-889 Optimal Sets for Games over the Square
RM-897 Reduction of Certain Games over Function Space
RM-901 Solution Sets for Games on the Square
★ RM-972 On Some Variational Problems Occurring in the Theory of Dynamic Programming—II
★ RM-973 On Some Variational Problems Occurring in the Theory of Dynamic Programming—III
★ RM-978 On Some Variational Problems Occurring in the Theory of Dynamic Programming—IV
★ RM-994 On Some Variational Problems Occurring in the Theory of Dynamic Programming—VI
RM-1102 A Production-line Assignment Problem
RM-1286 The Derivatives of the Value of a Game
RM-1318 On the Minimization of $\int_0^T |1 - x(t)| dt$

★ Indicates publications which are out of print.

- RM-1504 The Maximization of an Integral Subject to Constraints
- RM-1560 Notes on Linear Programming—Part XXVIII: A Simple Linear-programming Problem Explicitly Solvable in Integers
- RM-1603 A Search Problem Due to Bellman
- RM-1644 Notes on Linear Programming—Part XXX: A Class of Discrete-type Minimization Problems
- RM-1755 Games with Payoff Discontinuities at Discrete Points
- RM-1861 An Industrial-location Planning Problem
- RM-2132 Additive Generation of Pseudorandom Numbers
- RM-2265 A Class of Function-space Games
- RM-2279 An Optimal-inventory Model
- RM-2282 On the Computational Solution of Dynamic-programming Processes—XIV: Missile-allocation Problems
- RM-2320 A Mechanical Proof of the Min-Max Theorem
- RM-2368 A Note on Polynomial and Separable Games
- RM-2887-PR Minimum-weight Design for Moving Loads
- RM-2993-PR A Linear Program of Prager's: Notes on Linear Programming and Extensions—Part 60
- P-188 On Certain Games with Transcendental Values
- P-323 Polynomial-like Approximation
- ★ P-341 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-380 On Some Variational Problems Occurring in the Theory of Dynamic Programming
- P-456 Some Combinatorial Problems Arising in the Theory of Multistage Processes
- P-491 The Theory of Dynamic Programming as Applied to a Smoothing Problem
- P-552 On the "Bang-Bang" Control Problem
- P-557 A Rational Game on the Square
- P-572 On the Optimal Inventory Equation
- P-580 On the Optimal Inventory Equation
- P-594 Notes on Matrix Theory—VI
- P-636 Some Nonclassical Problems in the Calculus of Variations
- P-935 Sequential Minimax Search for a Zero of a Convex Function
- P-1216 A Note on Polynomial and Separable Games
- P-1630 The Bottleneck Assignment Problem
- P-1822 Some Special Search Problems
- P-1831 The Rational Points on a Transcendental Curve
- P-2040 On the Elementary Approach to Diophantine Equations
- P-2152 The Irrationality of the Zeros of the Bessel Functions, J_0 and J_1
- P-2159 Preferential Arrangements
- P-2298 The Rendezvous Value of a Metric Space

GROSSE, R. N.

- RM-1474 The Value of American Manufacturing Plant and Equipment

GRUENBERGER, F. J.

- P-1124 Comparison of American Rotary Electric Desk Calculators
- P-1245 Primes in the Thousandth Million
- P-1599 A Short History of Digital Computing in Southern California
- P-1751 Computing and Education
- P-1820 An Experiment in Chess Playing by Machine
- P-2460 Statistics on the First Six Million Prime Numbers
- P-2483 Secondary Schools and Computing
- P-2500 A Short Table of Prime Numbers
- P-2552 A One-day Look at Computing

★ Indicates publications which are out of print.

GUNNING, W. F.

- ★ RM-236 Summary of REAC Experience
- P-356 A Survey of Automatic Computers: Analog and Digital
- P-363 RAND's Digital Computer Effort

HABER, S. E.

- P-1504 Female Labor Force Participation and Economic Development

HADDEN, F. A.

- RM-958-1 A Field Trial of an Air Force Electronic Equipment Reliability Study Program
- RM-1257 Electronic Reliability and Supply Improvement Based on Failure Reporting and Presentation
- P-545 Methodology for Reliable Failure Reporting from Maintenance Personnel
- P-573 Techniques in Putting Failure Data to Work for Management
- P-578 Machine Testing for Deviation of Data from a Poisson Distribution

HADLEY, G. F.

- P-2421 Various Properties of the Poisson Distribution

HAIGHT, F. A.

- P-995 Queueing with Balking

HALD, M. W.

- RM-2096 A Selected Bibliography on Economic Development and Foreign Aid
- P-1439 Social Charges in the EEC Countries: Some Economic Aspects
- P-1668 The Export-Import Bank and Development Lending

HALL, J.

- RM-596 Matrix Multiplication Using Standard IBM Equipment

HALPERIN, M.

- RM-370 Estimation in Truncated Sampling Processes

HALPERN, A. M.

- RM-411 Political Trends in Japan
- RM-1331 Changing Japanese Attitudes toward Atomic Weapons
- RM-2561 Communist Strategy in Laos
- RM-2657 The Chinese Communist Line on Neutralism
- P-1324 Japanese Views on Extraterrestrial Law and Order
- P-1419 Broken Gems and Whole Tiles: A Review Article
- P-1987 Why Are the Chinese Nervous?
- P-2026 The Chinese Communist Line on Neutralism
- P-2230-1 The Foreign Policy Uses of the Chinese Revolutionary Model
- P-2382-1 Communist China's Demands on the World

HALPERN, J. M.

- RM-2636-RC The Lao Elite: A Study of Tradition and Innovation
- P-2161 The Role of the Chinese in Lao Society

HAMBURGER, W.

- RM-1539 Simple Distribution Functions for Inventory Control
- RM-1541 The Effectiveness of Alternative Flyaway Kits

HANUNIAN, N. A.

- RM-563 Estimating Output from Floor Space: Feasibility
- P-2412 The Relation of U.S. Fallout Casualties to U.S. and Soviet Options

★ Indicates publications which are out of print.

HARARY, F.

- P-2531 The Maximum Connectivity of a Graph
- P-2534 A Complementary Problem on Nonplanar Graphs

HARMAN, H. H.

- P-708 The Psychologist in Interdisciplinary Research
- P-710 Some Observations on Factor Analysis

HARPER, K. E.

- RM-2063 Studies in Machine Translation—1: Survey and Critique
- RM-2066-1 Studies in Machine Translation—6: Manual for Coding Russian Grammar
- RM-2068 Studies in Machine Translation—8: Manual for Postediting Russian Text
- RM-2069 Studies in Machine Translation—9: Bibliography of Russian Scientific Articles
- P-1241 A Glossary of Russian Physics on Punched Cards
- P-1588 The Use of Machines in the Construction of a Grammar and Computer Program for Structural Analysis
- P-1624 Studies in Machine Translation—8: Manual for Postediting Russian Text
- P-1896 Soviet Research in Machine Translation
- P-1941 Machine Translation of Russian Prepositions
- P-2327 Dictionary Problems in Machine Translation

HARRIS, T. E.

- RM-74 A Differential Equation with Random Shocks
- RM-289 Occurrence of Improbable States in a Modified Ehrenfest Model—Part I
- RM-302 A Model for the Reliability of Complex Mechanisms
- RM-321 Occurrence of Improbable States in a Modified Ehrenfest Model—Part II
- RM-357 On Positive Transformations
- RM-1624 Weight-feasibility Calculation for Shielding of Truck Passengers
- RM-1807 A Method for Estimating Engine Failure Rates
- RM-2317 On One-dimensional Neutron Multiplication
- RAOP-14 Branching Processes
- RAOP-38 On the Theory of Age-dependent Stochastic Branching Processes
- P-139 On a Theorem of Doob
- P-141 Recurrence Times for the Ehrenfest Model
- P-152 Some Mathematical Models for Branching Processes
- P-158 Expectations, Positive Transformations, and Tauberian Theorems
- P-189 Optimal Inventory Policy
- P-207 First Passage and Recurrence Distributions
- P-382 Studies in Functional Equations Occurring in Decision Processes
- P-728 The Existence of Stationary Measures for Certain Markov Processes
- P-767 Transient Markov Chains with Stationary Measures
- P-1020 The Random Functions of Cosmic-ray Cascades
- P-1563 A Mathematical Model for Multiplication by Binary Fission
- P-1666 A Lower Bound for the Critical Probability in a Certain Percolation Process

HARTNETT, J. P.

- RM-2516 A Review of Binary Boundary Layer Characteristics
- RM-2585 A Survey of Thermal Accommodation Coefficients
- P-1612 Heat Transfer from a Nonisothermal Disk Rotating in Still Air
- P-1729 A Review of Binary Boundary Layer Characteristics
- P-1730 Effect of Molecular Weight on Mass-transfer Cooling in a Laminar Boundary Layer on a Flat Plate
- P-1732 Mass-transfer Cooling in a Turbulent Boundary Layer
- P-2045 The Influence of Prandtl Number on the Heat Transfer from Rotating Non-isothermal Disks and Cones
- P-2473 A Brief Review of Mass Transfer Cooling

HASTINGS, C., JR.

- ★ R-264 Approximations for Digital Computers

★ Indicates publications which are out of print.

HASTINGS, C., JR.—continued

- RM-24 R-7.2 Maximization of a Function $\varphi(X, Y)$
- RM-32 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
- RM-50 Tables of Integrals Associated with the Error Function of a Complex Variable
- ★ RAOP-40 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
- P-114 Rational Approximation in High-speed Computing
- P-314 The RAND Collection of Illustrative Approximations
- P-317 Analytical Approximations
- P-330 Analytical Approximations, Volume II
- P-340 Analytical Approximations, Volume III
- P-348 Analytical Approximations, Volume IV
- P-355 Analytical Approximations, Volume V
- P-358 Analytical Approximations, Volume VI
- P-364 Analytical Approximations, Volume VII
- P-376 Analytical Approximations, Volume VIII
- P-387 Analytical Approximations, Volume IX
- P-397 Analytical Approximations, Volume X
- P-404 The Incomplete Approximator (In Six Fits)
- P-415 Analytical Approximations, Volume XI
- P-424 Approximations in Numerical Analysis: A Report on a Study
- P-426 Analytical Approximations, Volume XII
- P-441 Analytical Approximations, Volume XIII
- P-515 Analytical Approximations, Volume XIV
- P-555 Analytical Approximations, Volume XV
- P-559 Analytical Approximations, Volume XVI
- P-592 Analytical Approximations, Volume XVII
- P-595 Analytical Approximations, Volume XVIII
- P-601 Analytical Approximations, Volume XIX
- P-607 Analytical Approximations, Volume XX
- P-1033 Analytical Approximations, Volume XXI
- P-1098 Analytical Approximations, Volume XXII
- P-1117 Analytical Approximations, Volume XXIII
- P-1184 Analytical Approximations, Volume XXIV
- P-1208 Analytical Approximations, Volume XXV
- P-1217 Analytical Approximations, Volume XXVI
- P-1229 Analytical Approximations, Volume XXVII
- P-1301 Analytical Approximations, Volume XXVIII
- P-1627 Approximation Techniques in Dynamic Programming

HASTINGS, E.

- P-1033 Analytical Approximations, Volume XXI
- P-1098 Analytical Approximations, Volume XXII
- P-1117 Analytical Approximations, Volume XXIII
- P-1184 Analytical Approximations, Volume XXIV
- P-1208 Analytical Approximations, Volume XXV
- P-1217 Analytical Approximations, Volume XXVI
- P-1229 Analytical Approximations, Volume XXVII
- P-1301 Analytical Approximations, Volume XXVIII

HATCH, M. M.

- P-2522 Western Electronic Show and Convention (WESCON), San Francisco, California, 1961

HAURWITZ, B.

- P-2280 Frictional Effects and the Meridional Circulation of the Mesosphere

HAUSNER, M.

- RM-684 Decision Functions for Bombing Models

★ Indicates publications which are out of print.

- RM-697 An Embedding of a Mixture Space in a Vector Space
- RM-698 An Embedding of a Utility Space in an Ordered Vector Space
- RM-712 Separation Theorems for Convex Bodies
- RM-776 Games of Survival
- RM-777 Optimal Strategies in Games of Survival
- P-271 Ordered Vector Spaces
- P-336 Multidimensional Utilities

HAYASE, S.

- RM-2235 Design-change History of F-100 Hi-Valu Airframe Spare Parts

HAYDON, B. W.

- P-599 Communicating Research Results
- P-1339 The Writer, the Editor, the Publisher, and the Reader

HAYS, D. G.

- ★ RM-2060 Studies in Machine Translation—2: Research Methodology
- RM-2061 Studies in Machine Translation—5: Manual for Key punching Russian Scientific Text
- RM-2063 Studies in Machine Translation—1: Survey and Critique
- RM-2064 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- RM-2065 Studies in Machine Translation—4: Manual for Pre-editing Russian Scientific Text
- RM-2066-1 Studies in Machine Translation—6: Manual for Coding Russian Grammar
- RM-2068 Studies in Machine Translation—8: Manual for Postediting Russian Text
- RM-2069 Studies in Machine Translation—9: Bibliography of Russian Scientific Articles
- RM-2538 Studies in Machine Translation—10: Russian Sentence-structure Determination
- RM-2646 Grouping and Dependency Theories
- RM-2916-PR Research Procedures in Machine Translation
- P-1043 Comments on the Sociology of Management
- P-1218 Pairs of Russian Words with High Correlation
- P-1241 A Glossary of Russian Physics on Punched Cards
- P-1251 Studies in Machine Translation—2: Research Methodology
- P-1321 Automatic Computers in Machine-translation Research
- P-1352 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- P-1588 The Use of Machines in the Construction of a Grammar and Computer Program for Structural Analysis
- P-1624 Studies in Machine Translation—8: Manual for Postediting Russian Text
- P-1632 Order of Subject and Object in Scientific Russian When Other Differentia Are Lacking
- P-1720 A Russian Structure for Comparison
- P-1866 Automatic Language-data Processing in Sociology
- P-1900 Linguistic Research at The RAND Corporation
- P-1910 Grouping and Dependency Theories
- P-1962 Automatic Content Analysis: Some Entries for a Transformation Catalog
- P-1984 Basic Principles and Technical Variations in Sentence-structure Determination
- T-143 A Probability Model of Perception

HAYTHORN, W. W.

- P-1075 Simulation in RAND's Logistics Systems Laboratory
- P-1456 Simulation in RAND's Logistics Systems Laboratory: Laboratory Problem 1
- P-1656 The Use of Simulation in Estimating Intrasquadron Logistics Requirements: A Description of LP-II, Phase 1.1
- P-1791 The Use of Simulation in Logistics Policy Research
- P-1988 An Analysis of the Decisionmaking Functions of a Simulated Air-defense Direction Center
- P-2302 Maintenance Scheduling Decisions and the Importance of Information
- P-2337 Human Factors in Systems Research

HAYWARD, J. T.

- ★ R-264 Approximations for Digital Computers

★ Indicates publications which are out of print.

HAYWOOD, O. G., JR., COL., USAF

RM-528 Military Doctrine of Decision and the von Neumann Theory of Games

HEARLE, E. F. R.

- P-1924-RC The Potential of Electronic Data Processing in Municipal Government
- P-2062-RC The Future of Data Processing in State Government
- P-2260 How Useful Are "Scientific" Tools of Management?
- P-2452 Possible Economies through Electronic Data Processing
- P-2454 Can EDP Be Applied to All Police Agencies?
- P-2492 Data Processing for Cities
- P-2557 A Data Processing System for State and Local Governments

HEISLER, K. G.

- RM-2445 Descriptive Guide to a Card Directory of U.S. Military Radio Communication Equipment
- P-1724 Military Radio Communications Equipment Trade-offs

HELMER, O.

- RA-15015 A Problem in Logistics: The Jeep Problem
- RA-15019 A Problem in Logistics: The Jeep Problem (Part 2)—App. IV to Fourth Quarterly Report, RA-15033
- R-353 On the Epistemology of the Inexact Sciences
- RM-5 Randomness
- RM-6 Combat between Heterogeneous Forces
- RM-10 An Experiment in Estimation
- RM-42 Some Examples of Games with Continuous Payoff Functions
- RM-319 Local Defense of Targets of Equal Value
- RM-502 Games with Positive-density Solutions
- RM-608 Factorable Games
- RM-727 The Use of Experts for the Estimation of Bombing Requirements: A Project Delphi Experiment
- RM-1882 Deterrence
- RM-2754 Glossary of Terms on National Security
- P-245 An Analysis of Three-move Finite Games
- P-1026 The Game-theoretical Approach to Organization Theory
- P-1053 The Prospects of a Unified Theory of Organizations
- P-1144 Deterrence
- P-1513 On the Epistemology of the Inexact Sciences
- P-1902 Strategic Gaming
- P-2346 Glossary of Terms on National Security
- T-25 Undetermined Wage Problems

HEMPSTEAD, G. S.

- P-692 PACT Loop Expansion

HENNESSEY, R.

- P-447 Experiments on "The Cortical Correlate of Pattern Vision"

HERBST, R. F.

- P-2399 Detection of Nuclear Explosions

HERRICK, S.

- P-1303 Trajectory Fundamentals
- P-1442 Some Aspects of Astronautics
- P-1559 The Status and Improvement of Physical Constants Needed for Precision Trajectories

HERSTEIN, I. N.

- P-298 Comments on Solow "Structure of Linear Models"
- P-318 Nonnegative Square Matrices
- P-319 An Axiomatic Approach to Measurable Utility
- P-344 A Note on Primitive Matrices
- P-385 Some Mathematical Methods and Techniques in Economics

HERZ, J. H.

P-528-RC Political Views of the German Civil Service

HESTENES, M. R.

RM-100 A General Problem in the Calculus of Variations with Applications to Paths of Least Time

RM-102 Numerical Methods of Obtaining Solutions of Fixed End Point Problems in the Calculus of Variations

HEUSTON, A.

RM-1917-1 The Game Monopologs

RM-2656 Base-depot Requisitioning Pipeline Times

HEUSTON, M. C.

RM-2611 Concepts for Estimating Air Force Manpower Requirements for Planning Purposes

P-2051 Manpower Planning for the Space Age

HEWITT, E.

T-14 Collection of Articles on the Theory of Firing

HEYMAN, H., JR.

R-253 Soviet National Income and Product, 1940 through 1948

★ RM-122 National Income of the USSR in 1940: Preliminary Report

RM-154 On the Territorial Coverage of Soviet Official Statistics for Years since 1939

★ RM-155 Comparisons of Bergson-Heymann and Baran Calculations of Soviet National Income for 1940

★ RM-278 National Income and the Disposition of Gross National Product in Adjusted Rubles, USSR, 1940

★ RM-283 National Economic Accounts of the USSR in 1948: Preliminary Report

★ RM-287 Disposition of National Product of the USSR in 1948 in Terms of Adjusted Ruble Prices

★ RM-328 Disposition of the Gross National Product of the USSR in 1937, 1940, and 1948

RM-393 Profits and Subsidies in Soviet Economic Accounts

★ RM-566 National Economic Accounts of the USSR in 1944: Preliminary Report

RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan

RM-2213 The Soviet Role in International Civil Aviation

RM-2544 Soviet National Income and Product, 1928-48: Revised Data

P-1047 Soviet Trade and Aid: Trickle or Torrent?

P-1269 Future Prospects for Soviet Economic Aid

P-1507 A Comment on "Costs, Freight Rates, and Location Decisions in the USSR"

P-1754 The USSR in the Technological Race

P-1769 Soviet Foreign Aid as a Problem for U.S. Policy

P-1943 Communist Economic Subversion: A Reappraisal

P-2479 Aviation and International Relations

P-2486 Air Transport and Economic Development: Some Comments on Foreign Aid Programs

HIGGINS, T. P., JR.

P-51 Effect of Creep on Column Deflection

P-218 Time-dependent Stress-Strain Distributions

HILL, J. E.

RM-1285-1 Effects of Environment in Reducing Dose Rates Produced by Radioactive Fallout from Nuclear Explosions

P-785 The Impact Theory of the Origin of Lunar Craters

P-801 Application of the Baldwin Crater Relation to the Scaling of Explosion Craters

P-836 The Impact of Large Meteorites

P-2414 Problems of Fire in Nuclear Warfare

★ Indicates publications which are out of print.

HILL, L. S.

- P-2037 The Commercial Aircraft Bomb Hazard: A Possible Answer
- P-2065 A Model Punched Card System for Production Control
- P-2295 An Introduction to Automated Production Control System
- P-2497 Automatic Data-processing for Production Control

HIMES, B. T.

- RM-227 Photoelectric Coverage Machine
- RM-251 The Potentialities of the Photoelectric Coverage Machine
- RM-317 Application of the Photoelectric Machine: Expected Damage by a Single Weapon

HINTON, H. C.

- RM-1845 Leaders of Communist China

HIRSCH, W. M.

- RM-1383 Notes on Linear Programming—Part XIX: The Fixed-charge Problem
- P-648 The Fixed-charge Problem

HIRSCHMAN, A. O.

- P-1982 Economic Development, Research and Development, Policymaking: Some Converging Views

HIRSHLEIFER, J.

- R-258-RC A Brief Survey of the Technology and Economics of Water Supply
- RM-367 The Economic War Potential of the United States and the Soviet Union
- P-406 The Exchange between Quantity and Quality
- P-420 The Supply of Female Labor in World War II
- P-517 Compensation for War Damage: An Economic View
- P-519 War Damage Insurance
- P-674 Some Thoughts on the Social Structure after a Bombing Disaster
- P-1034-RC Feather River Water for Southern California
- P-1158 An Isoquant Approach to Investment Decision Problems
- P-1169-RC Does Efficient Peak-load Pricing Involve Discrimination?
- P-2057-RC Water Supply for Southern California: Rationalization or Expansion?
- P-2143 Risk, the Discount Rate, and Investment Decisions
- P-2410 An Exposition of the Equilibrium of the Firm: Symmetry of the Product and Factor Analyses
- P-2448 The Firm's Cost Function: A Successful Reconstruction?

HITCH, C. J.

- R-346 The Economics of Defense in the Nuclear Age
- P-105 Planning Defense Production
- P-326 Suboptimization in Operations Problems
- P-699 An Appreciation of Systems Analysis
- P-870 Professor Koopmans on Fallacies: A Comment
- P-1250 Economics and Military Operations Research
- P-1297 The Character of Research and Development in a Competitive Economy
- P-1758 A Further Comment on Economics and Operations Research
- P-1776 National Security Policy as a Field for Economics Research
- P-1955 On the Choice of Objectives in Systems Studies
- P-1959 Uncertainties in Operations Research
- P-2155 What Can Managerial Economics Contribute to Economic Theory?
- P-2179-RC The Uses of Economics

HO, Y. C.

- RM-3015-PR A Computational Procedure for Optimizing Interplanetary Trajectories
- P-2402 A Computational Procedure for Optimal Control Problems with State Variable Constraint

HOAG, M. W.

- RM-1678 An Introduction to Systems Analysis
- RM-1926-RC NATO Deterrent vs. Shield

- P-820 The Relevance of Costs in Operations Research
- P-922 Is "Dual" Preparedness More Expensive?
- P-1025 Klaus Knorr on War Potential: A Brief Review
- P-1030 Operations Research: A New Science?
- P-1035 What Is a System?
- P-1080-RC Economic Problems of Alliance
- P-1103-RC NATO Deterrent vs. Shield
- P-1195 Economics of a Dual Capability
- P-1242-RC On NATO Pooling
- P-1531 Some Complexities in Military Planning
- P-1566 The Place of Limited War in NATO Strategy
- P-1571 Some Political and Economic Aspects of Overseas Missile Bases
- P-1692 The Content of Economics
- P-1748 What Interdependence for NATO?
- P-2433 On Local War Doctrine

HOCKETT, C. F.

- P-2338 The Quantification of Functional Load

HOEFFDING, O.

- R-255 Soviet National Income and Product in 1928
- ★ RM-917 National Income of the USSR in 1928
- RM-1173 The New Soviet Plans for Agriculture and Consumption
- RM-1567 Recent Trends in Soviet Trade
- RM-2101 Soviet National Income and Product, 1949-1955
- RM-2202 The Condition of the Soviet Economy
- RM-2544 Soviet National Income and Product, 1928-48: Revised Data
- P-739 Recent Trends in Soviet Trade
- P-1354 Soviet Industry Five Years after Stalin
- P-1377 Strategy and Economics: A Soviet View
- P-1450 Soviet State Planning and Forced Industrialization as a Model for Asia
- P-1569 The Soviet Industrial Reorganization of 1957
- P-1607 The Soviet Seven Year Plan
- P-1768 Recent Efforts toward Coordinated Economic Planning in the Soviet Bloc
- P-2087 Sino-Soviet Economic Relations in Recent Years
- P-2493 The 22nd Congress of the CPSU: Some Domestic Implications
- T-95 On the Prevention of Surprise Attack

HOFFENBERG, M.

- R-318 A Time Series Analysis of Interindustry Demands
- RM-1202 Approaches to Soviet Inter-industry Relationships

HOFFMAN, A. J.

- RM-1553 Notes on Linear Programming--Part XXVII: Dilworth's Theorem on Partially Ordered Sets

HOFFMAN, F. S.

- RM-464 Comments on the Modified Form of Aircraft Progress Function
- P-1582 The Economic Analysis of Defense: Choice without Markets

HOFFMAN, G. A.

- RM-1868 Fibered Materials for Flight Structures
- RM-2127 A Criterion for Choosing Sheet Tolerances in Aircraft Materials
- RM-2263 On the Linear Relation between the Softening Temperature and the Melting Point of Ceramics
- RM-2341 Nickel, Columbium, Molybdenum, and Tungsten: A Preliminary Structural Comparison

★ Indicates publications which are out of print.

HOFFMAN, G. A.—continued

- RM-2490-1 Thermoelectric Powerplants Utilizing Contained Nuclear Explosions
- RM-2675 Minimum-weight Proportions of Pressure-vessel Heads
- P-871 Beryllium as an Aircraft Structural Material
- P-946 Poisson's Ratio for Honeycomb Sandwich Cores
- P-1149 The Structural Exploitation of the Strength of "Whiskers"
- P-1294 The Exploitation of the Strength of "Whiskers"
- P-1330 Poisson's Ratio for Honeycomb Sandwich Cores
- P-1420 Materials for Space Flight
- P-1605 Optimum Tolerances of Sheet Materials for Flight Vehicles
- P-1606 The Linear Relation between the Softening Temperature and the Melting Point of Ceramics
- P-1637 The Design of Large-area Astronautical Objects
- P-1760 Future Possibilities in Fibered Material
- P-1974 The Effect of Filamentary Materials on Pressure-vessel Design
- P-2137 Minimum-weight Proportions of Pressure Vessel Heads
- P-2422 The Automobile—Today and Tomorrow

HOFFMAN, W. C.

- P-749 The Power Spectrum of the Turbulent-scattered Field
- P-1263 Studies of Ionospheric Radiophysics by Means of Satellites
- P-1396 Some Statistical Methods of Potential Value in Radio Wave Propagation Investigations
- P-1528 Statistical Methods in Radio-wave Propagation
- P-1557 The Symposium on the Use of Space Vehicles at the Fall, 1958, URSI Meeting
- T-47 The Influence of Weak Atmospheric Inhomogeneities upon the Propagation of Sound and Light

HOGAN, J. C.

- P-1087 Space Law Bibliography
- P-1088 Legal Terminology for the Upper Regions of the Atmosphere and for the Space beyond the Atmosphere
- P-1290 A Guide to the Study of Space Law, Including a Selective Bibliography on the Legal and Political Aspects of Space
- P-1324 Japanese Views on Extraterrestrial Law and Order

HOLBROOK, R. D.

- RM-2161 Outline of a Study on Extraterrestrial Base Design
- RM-2174 Lunar Base Study Jury Report: Evaluation of an Experiment in Creative Design Conducted with College Students
- RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
- P-1304 Certain Ecological Aspects of a Closed Lunar Base
- P-1436 Lunar-base Planning Considerations
- P-2046 On the Problem of Ballistic Missile Defense
- T-58 Steady Nuclear Combustion in Rockets

HOLLAND, J.

- P-1551 On an Application of Dynamic Programming to the Synthesis of Logical Systems

HOLTON, R. H.

- RM-2722 Decision Rules for the Disposal of Excess Air Force Stock

HOOPER, J. W.

- P-1510 Simultaneous Equations and Canonical Correlation Theory
- P-1685 The Aggregation of Servicing Facilities in Queueing Processes

HOPP, D. S.

- P-1807 Tables of the Binomial Probability Distribution $b(r; N, p)$ for Large N and Small p

HORELICK, A. L.

- RM-2618 "Deterrence" and Surprise Attack in Soviet Strategic Thought
- P-2016 "Deterrence" and Surprise Attack in Soviet Strategic Thought

- P-2480 The Soviet Union and the Political Uses of Outer Space
- P-2542 Notes on a Conference with Soviet Scientists
- T-97 Some Soviet Views on the Nature of a Future War and the Factors Determining Its Course and Outcome

HORN, M. C.

- RM-1524 Transient Heat Conduction in Composite Slabs for a Heat Flux Varying Exponentially with Time

HOUGHTEN, J. W.

- RM-2722 Decision Rules for the Disposal of Excess Air Force Stock

HOUSEHOLDER, A. S.

- RM-671 Neural Nets for "Toad T1"
- RM-678 Some Notes for Simple Pavlovian Learning
- RM-953 Some Group Interaction Models

HOWARD, W. J.

- RM-87 Examination of Some Models of Failure of Equipment during Operation
- RM-1058 Chain Reliability: A Simple Failure Model for Complex Mechanisms
- RM-1724 Some Physical Qualifications for Reliability Formulas

HSIA, R.

- RM-2207 Government Acquisition of Agricultural Output in Mainland China, 1953-56

HSIEH, A. L.

- RM-2534 The Significance of Chinese Communist Treatment of Khrushchev's January 14 Speech on Strategy
- RM-2595 The Chinese Genie: Peking's Role in the Nuclear Test Ban Negotiations
- P-1894 Communist China and Nuclear Warfare
- P-2022 The Chinese Genie: Peking's Role in the Nuclear Test Ban Negotiations

HUBER, C. R.

- P-2224 Correlation of Rock Properties by Statistical Methods

HUGGINS, W. H.

- RM-2462 Signal Detection in a Noisy World

HUNDLEY, R. O.

- RM-2641 A Study of the Feasibility of Detecting Nuclear Explosions by Means of Anti-neutrinos
- P-2441 Satellite Charge-up in the Outer Van Allen Belt

HUNGERFORD, J. M.

- RM-365 The Exploitation of Superstitions for Purposes of Psychological Warfare

HUNTZICKER, J. H.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- RM-770 A Hypersonic Approximation of the Pressure Forces on Ogives
- RM-2174 Lunar Base Study Jury Report: Evaluation of an Experiment in Creative Design Conducted with College Students
- T-109 Radiointerference Phenomena Caused by the Ionosphere of the Moon

HURWICZ, L.

- ★ P-223 A Gradient Method for Approximating Saddle Points and Constrained Maxima
- P-706 Reduction of Constrained Maxima to Saddle-point Problems
- P-928 Gradient Methods for Constrained Maxima
- P-1015 On Gradient Methods for Approaching Constrained Maxima

HUTCHESON, J. H.

- P-1460 Earth-period (24-hour) Satellites

★ Indicates publications which are out of print.

HUTH, J. H.

- RM-844 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part I: Noses and Cylinders
RM-905 Axial and Normal Force Coefficients for Pointed Bodies of Revolution at Super- and Hypersonic Speeds—Part II: Boattails
RM-992 Inviscid Aerodynamics of Missiles with Noncircular Cross Sections
RM-1181 A Theoretical Treatment of Spalling
RM-1524 Transient Heat Conduction in Composite Slabs for a Heat Flux Varying Exponentially with Time
RM-1762 Estimating Ground Motions Resulting from Air-induced Ground Shocks
RM-2194 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
P-274 Thermal Stresses in a Partially Clamped Elastic Half-plane
P-304 Thermal Stresses in Conical Shells
P-359 Constant-strain Waves in Strings
P-467 Impulsive Loading on an Elastic Half-plane
P-541 A Note on Plastic Torsion
P-614 Elastic Stress Waves Produced by Pressure Loads on a Spherical Shell
P-746 A New Approach to Penetration Mechanics
P-884 Elastic Stresses Produced in a Half Plane by Steadily Moving Loads
P-1187 Fuel Cells: Current Problems and Potential Usefulness
P-1244 Electric Power for Space Flight
P-1318 A Discussion of Energy Sources for Space-communications
P-1389 Power in Space
P-1438 Food Preservation
P-1479 Some Fundamental Considerations Relating to Advanced Rocket Propulsion Systems
P-1511 Power for Satellites
P-1524 Direct-power Conversion—Part I: General Comments
P-1628 Comments on Electrical Power Supplies for Underground Shelters
P-1695 Some Interior Problems of Hydromagnetics
P-1827 On One-dimensional Inviscid Magneto hydrodynamic Flow
P-1861 Space Vehicle Power Plants
P-1944 Electrical Power from Rockets
P-2012 Electrical Power from Magneto hydrodynamic (MHD) Generators
T-49 On Waves of Loading and Unloading, Arising from the Motion of an Elastic or Plastic Flexible Fibre

IGLEHART, D. L.

- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
P-2207 Asymptotic Behavior of the Total Cost Function for Dynamic Inventory Processes

IKLÉ, D. M.

- P-2077 Southern California's Economy in the Sixties
P-2255 How Arms Controls Would Affect the National Security Budget

IKLÉ, F. C.

- RM-1893 The Growth of China's Scientific and Technical Manpower
P-720 Demographic Interaction Analysis and Its Bearing on Small Group Studies
P-1104 The Growth of China's Scientific and Technical Manpower
P-1956 "Nth Countries" and Disarmament
P-2000 The Violation of Arms Control Agreements: Deterrence vs. Detection
P-2482 Political Negotiation as a Process of Modifying Utilities

ISAACS, R. P.

- RM-482 The Evaluation of a Definite Integral
RM-791 A Pursuit Game with Incomplete Information
RM-1087 A Problem in Programming Steel Production and Its Solution by Differential Game Theory

- RM-1316 A Game of Aiming and Evasion
- RM-1385 A Game of Aiming and Evasion: General Discussion and the Marksman's Strategies
- RM-1391 Differential Games—I: Introduction
- RM-1399 Differential Games—II: The Definition and Formulation
- RM-1411 Differential Games—III: The Basic Principles of the Solution Process
- RM-1486 Differential Games—IV: Mainly Examples
- P-73 Iterates of Fractional Order
- P-101 Transtability Flutter of Supersonic Aircraft Panels
- P-257 Games of Pursuit
- P-642 The Problem of Aiming and Evasion

ISARD, W.

- P-1099 Regional Science Techniques Applicable to Regional Planning

JACOBS, E. H.

- RM-693 Some Remarks on the Double Description Method

JACQUEZ, J. A., M.D.

- P-1550-RC Some Mathematical Aspects of Chemotherapy—I: One-organ Models
- P-1560-RC The Distribution of a Drug in the Body
- P-2102-RC Mathematical Models of Chemotherapy
- P-2154 New Version of a Two-organ Chemotherapy Model

JANIS, I. L.

- ★ R-212 Air War and Emotional Stress: Psychological Studies of Bombing and Civilian Defense
- RM-161 Are the Cominform Countries Using Hypnotic Techniques To Elicit Confessions in Public Trials?

JANSSEN, E.

- P-214 The Compressible Boundary Layer

JENKINS, J. L.

- P-1178 An Airborne Collision-warning Device
- P-1285 A Simple Device for Assessing Gun-camera Film against Banner Targets

JITLOV, V. S.

- T-50 Soviet Schools in Science: Translation of and Comments on a Russian *Literary Gazette* Article
- T-62 Results of Experiments in Organizing the Stepwise Scheduled Routes on the RR Line Korosten-Odessa: By Dul'Nye, Furman, Baranov, and Sin'Yov
- T-72 Excerpt from "Construction of Aircraft" (*Konstruktsii Samoletov*) Dealing with the Evolution and Uses of Soviet Airplanes
- T-74 On the Problem of a Streamlined Profile in a Near-sonic Flow

JOHNSON, D. G.

- RM-1561 A Study of the Growth Potential of Agriculture of the USSR

JOHNSON, L. L.

- P-1308 The Theory of Hedging and Speculation in Commodity Futures

JOHNSON, R. E.

- RM-2731 An Experiment in Aircraft Status Prediction
- P-2435 Status Prediction of Scheduled Equipment

JOHNSON, R. P.

- RM-2107 Drag Transformation and Reduction for Bodies of Revolution
- RM-2208 Aerodynamic Characteristics and Geometric Properties of Half- and Complete-ring-body Configurations for Supersonic Design Mach Number
- RM-2260 Theoretical Development for Lifting Ring-Body Configurations
- P-690 A System for Cataloguing Reference Material

★ Indicates publications which are out of print.

JOHNSON, S. M.

- RM-617 What Is a Sensitivity Analysis?
RM-1171 A Tactical Air Game
RM-1432 Notes on Linear Programming—Part XXIII: A Production Smoothing Problem
RM-1590 Best Exploration for Maximum Is Fibonacci
RM-1652 Optimal Sequential Testing
RM-1861 An Industrial-location Planning Problem
RM-1976 Notes on Linear Programming—Part XLIII: A Feasibility Algorithm for One-way Substitution in Process Analysis
RM-2132 Additive Generation of Pseudorandom Numbers
RM-2282 On the Computational Solution of Dynamic-programming Processes—XIV: Missile-allocation Problems
RM-2321 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem: Notes on Linear Programming and Extensions—Part 49
RM-2398 A Game Solution to a Missile-launching Scheduling Problem
RM-2519 A Mathematical Model of the Human External Respiratory System
RM-2723 Optimal Timing in Missile Launching: A Game-theoretic Analysis
P-328 A Bayes Model in Sequential Design
P-402 Optimal Two- and Three-stage Production Schedules with Setup Times Included
P-510 Solution of a Large-scale Traveling-salesman Problem
P-610 A Production Smoothing Problem
P-856 Best Exploration for Maximum Is Fibonacci
P-921 Upper Bounded Variables in Linear Programming
P-935 Sequential Minimax Search for a Zero of a Convex Function
P-941 A Feasibility Algorithm for One-way Substitution in Process Analysis
P-989 Sequential Production Planning over Time at Minimum Cost
P-1059 Chemical Equilibrium in Complex Mixtures
P-1060 A Linear-programming Approach to the Chemical Equilibrium Problem
P-1063 A Tactical Air Game
P-1115 A Linear Diophantine Problem
P-1215 A Tournament Problem
P-1281 On a Linear-programming-Combinatorial Approach to the Traveling-salesman Problem
P-1448 An Equivalent Linear-programming Problem
P-1526 Sequencing n Jobs on Two Machines with Arbitrary Time Lags: Alternate Proof and Discussion of General Case
P-1811 A Mathematical Model of the Human External Respiratory System
P-2151 Optimal Sequencing of Serial Memory Transfers
P-2294-2 A New Upper Bound for Error Correcting Codes

JOHNSTON, R. B.

- P-1539 Supersonic Transports
P-1575 Some Military Aspects of Supersonic Transports
P-2049 Low-cost Cargo Aircraft: Turboprop or Turbofan?

JOHNSTONE, W. C., JR.

- RM-2535-RC Observations on Contemporary Burma

JONAS, A. M.

- RM-2290 The Soviet Union and the Atom: Peaceful Sharing, 1954–1958
RM-2438 Khrushchev's Major Informal Interviews with Non-bloc Leaders, January 1, 1957–August 1, 1959: A Selected Bibliography and Chronology
P-1741 Peaceful Atomic-energy Programs in Soviet Bloc Nations
P-2214 Laos: The Current Phase in a Cyclic Regional Revolution
T-78 The Artificial Satellite and International Law

JONES, T. V.

- ★ R-249 Capabilities and Operating Costs of Possible Future Transport Airplanes

★ Indicates publications which are out of print.

JONES, W. M., LT. COL., USAF

- RM-2415 The Flight Operations Planner
- RM-2525 Addendum to RM-2415, *The Flight Operations Planner*

JORDAN, N.

- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- P-2156 Decisionmaking under Uncertainty and Problem Solving: A Gestalt Theoretical Viewpoint
- P-2166 Some Thinking about "System"
- P-2199 Four Types of Learning: A Phenomenological Analysis
- P-2258 Why We Cannot Build "Thinking Machines" (At Least at Present)
- P-2273 The Application of Human Relations Research to Administration
- P-2310 The Allocation of Functions between Man and Machines in Automated Systems
- P-2332 Motivational Problems in Human-computer Operations
- P-2442 The Resolution of Cognitive Conflict under Uncertainty: A Critique
- P-2444 Perception, Cognition and Science
- P-2459 Human Factors Aspects in Maintainability
- P-2472 Imbalance in Balance "Theory"

JORGENSEN, D. W.

- P-1852 Multiple Regression Analysis of a Poisson Process
- P-2074 Optimal Replacement and Inspection of Stochastically Failing Equipment

JUDD, H. A. (INTERNATIONAL BUSINESS MACHINES CORPORATION)

- P-842 Manual for the RAND IBM Code for Linear Programming on the 704
- P-907 The Storage Allocation of the Linear Programming Code
- P-914 Preparation of Input for the Linear Programming Code
- P-925 Printing and Checking for Linear Programming Codes

JUDD, W. R.

- P-2224 Correlation of Rock Properties by Statistical Methods

JUNCOSA, M. L.

- RM-1687 Communication Networks—I: Optimal Design and Utilization
- RM-1688 Communication Networks—II: Interoffice Trunking Problems
- RM-2286 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- P-465 On the Crank-Nicolson Procedure for Parabolic Partial Differential Equations
- P-499 On the Convergence of a Procedure of Dufort and Frankel for the Numerical Solution of Parabolic Partial Differential Equations
- P-782 Optimal Design and Utilization of Communication Networks
- P-844 Optimal Utilization and Extension of Interoffice Trunking Facilities
- P-964 General Systems Approaches to Telecommunication Optimization Problems
- P-1709 SPADE: A Set of Subroutines for Solving Elliptic and Parabolic Partial Differential Equations
- P-1723 Machine Analysis Methods for Network Vulnerability Problems
- P-1781 On the Increase of Convergence Rates of Relaxation Procedures for Elliptic Partial Difference Equations
- P-2200 Some Numerical Experiments Using Newton's Method for Nonlinear Parabolic and Elliptic Boundary-value Problems
- T-51 On the Spectrum of Singular Boundary-value Problems for Elliptic Differential Equations

JWAIDEH, A. R.

- ★ RM-974 International Communication and Political Warfare: An Annotated Bibliography

KAEICHELE, I. E.

- RM-1895 Minimum-weight Design of Sandwich Panels
- RM-1963 Design Procedures and Data for Sandwich Panel Tests

★ Indicates publications which are out of print.

KAHN, H.

- ★ R-170 Gamma-ray Absorption Coefficients
- ★ RM-34 Determination of Shield Thickness for Attenuation of Air-scattered Gamma Radiation
- RM-43 Aerodynamics of Spheres
- ★ RM-49 Elastic Scattering of Neutrons
- RM-81 Preliminary Analysis of Effective Polarization on Gamma-ray Transmission
- RM-248 Particle Histories for Plane Slabs
- RM-787 A Simplified Study of Reconnaissance in Strategic Bombing Campaigns
- RM-1237-AEC Applications of Monte Carlo
- RM-1829 Techniques of Systems Analysis
- RM-1880 Graphs of Partial Sums of the Binomial Distribution
- RM-1937 Ten Common Pitfalls
- RM-2206-RC Some Specific Suggestions for Achieving Early Non-military Defense Capabilities and Initiating Long-range Programs
- P-88 Stochastic (Monte Carlo) Attenuation Analysis
- P-132 Modification of the Monte Carlo Method
- P-337 Methods of Reducing Sample Size in Monte Carlo Computations
- P-439 Note on the Numerical Treatment of Second-order Differential Equations
- P-766 Use of Different Monte Carlo Sampling Techniques
- P-1165 Monte Carlo
- P-1166 Game Theory
- P-1167 War Gaming
- P-1485 Multiple Quadrature by Monte Carlo
- P-1497-RC Major Implications of a Current Nonmilitary Defense Study
- P-1888-RC The Nature and Feasibility of War and Deterrence

KAIN, J. F.

- RM-2878-FF A First Approximation to a RAND Model for Study of Urban Transportation
- P-2489 The Journey-to-Work as a Determinant of Residential Location

KALABA, R. E.

- RM-1687 Communication Networks—I: Optimal Design and Utilization
- RM-1688 Communication Networks—II: Interoffice Trunking Problems
- RM-2189 Some Applications of Dynamic Programming to Communication and Information Theory
- RM-2288 Invariant Imbedding and Wave Propagation in Stochastic Media
- RM-2396 On Control of Reactor Shutdown Involving Minimal Xenon Poisoning
- RM-2924-PR Some Aspects of Quasilinearization
- RM-3084-PR Polynomial Approximation: A New Computational Technique in Dynamic Programming—I: Allocation Processes
- RM-3113-PR Some Numerical Results Using Quasilinearization for Nonlinear Two-point Boundary Value Problems
- P-414 A Simple Derivation of the Poisson Distribution
- P-782 Optimal Design and Utilization of Communication Networks
- P-839 On the Principle of Invariant Imbedding and Propagation through Inhomogeneous Media
- P-844 Optimal Utilization and Extension of Interoffice Trunking Facilities
- P-949 On the Role of Dynamic Programming in Statistical Communication Theory
- P-950 Linear Programming
- P-964 General Systems Approaches to Telecommunication Optimization Problems
- P-976 On the Principle of Invariant Imbedding and Diffuse Reflection from Cylindrical Regions
- P-996 On the Principle of Invariant Imbedding and One-dimensional Neutron Multiplication
- P-1102 On the Principle of Invariant Imbedding and Neutron Transport Theory—I: One-dimensional Case
- P-1113 Random Walk, Scattering, and Invariant Imbedding—I: One-dimensional Discrete Case
- P-1163 On Nonlinear Differential Equations, the Maximum Operation, and Monotone Convergence

★ Indicates publications which are out of print.

- P-1194 On Communication Processes Involving Learning and Random Duration
- P-1223 On Weighted PCM and Mean Square Deviation
- P-1232 A Note on Preventative Sampling
- P-1239 Invariant Imbedding, Wave Propagation, and the WKB Approximation
- P-1252 Invariant Imbedding and Neutron Transport Theory—II: Functional Equations
- P-1325 On Some Communication Network Problems
- P-1380 Invariant Imbedding and Neutron Transport Theory: A Generalized Approach
- P-1390 Invariant Imbedding and Generalized Transport Theory: A Basic Stochastic Functional Equation
- P-1408 Invariant Imbedding and Neutron Transport Theory—III: Neutron-Neutron Collision Processes
- P-1416 Dynamic Programming and Adaptive Processes—I: Mathematical Foundation
- P-1417 On k th Best Policies
- P-1471 Invariant Imbedding and Wave Propagation in Stochastic Media
- P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
- P-1500 On Control of Reactor Shut-down Involving Minimal Xenon Poisoning
- P-1525 *Calculus of Variations and Its Applications*: A Book Review
- P-1529 Functional Equations, Wave Propagation, and Invariant Imbedding
- P-1550-RC Some Mathematical Aspects of Chemotherapy—I: One-organ Models
- P-1551 On an Application of Dynamic Programming to the Synthesis of Logical Systems
- P-1560-RC The Distribution of a Drug in the Body
- P-1573 Functional Equations in Adaptive Processes and Random Transmission
- P-1610 On Adaptive Control Processes
- P-1614 Invariant Imbedding, Random Walk, and Scattering—II: Discrete Versions
- P-1699 A Mathematical Theory of Adaptive Control Processes
- P-1700 Invariant Imbedding and Neutron Transport in a Rod of Changing Length
- P-1778 Dynamic Programming and Feedback Control
- P-1797 Transport Theory and Invariant Imbedding
- P-1798 Some Optimization Problems in Chemical Engineering
- P-1809 Some Aspects of Adaptive Control Processes
- P-1835 Invariant Imbedding and Neutron Transport Theory—V: Diffusion as a Limiting Case
- P-1858 Invariant Imbedding and Mathematical Physics—I: Particle Processes
- P-1911 Some Mathematical Aspects of Optimal Predation in Ecology and Boviculture
- P-1923 Applications of Dynamic Programming to Space Guidance, Satellites, and Trajectories
- P-1952 Dissipation Functions and Invariant Imbedding—I
- P-1964 Reduction of Dimensionality, Dynamic Programming, and Control Processes
- P-1973 Dynamic Programming, Sequential Estimation, and Sequential Detection Processes
- P-2011 Some Mathematical Aspects of Optimization Problems in Engineering
- P-2014 Invariant Imbedding, Conservation Relations, and Nonlinear Equations with Two-point Boundary Values
- P-2071 Invariant Imbedding and the Reduction of Two-point Boundary Value Problems to Initial Value Problems
- P-2102-RC Mathematical Models of Chemotherapy
- P-2122 Invariant Imbedding and Variational Principles in Transport Theory
- P-2130 Dynamic Programming, Fermat's Principle, and the Eikonal Equation
- P-2163 On the Fundamental Equations of Invariant Imbedding—I
- P-2200 Some Numerical Experiments Using Newton's Method for Nonlinear Parabolic and Elliptic Boundary-value Problems
- P-2210 Computational Considerations for Some Deterministic and Adaptive Control Processes
- P-2241 Interrupted Stochastic Control Processes
- P-2268 On a New Computational Solution of Time-dependent Transport Processes—I: One-dimensional Case
- P-2324 Dynamic Programming and the Variational Principles of Classical and Statistical Mechanics
- P-2328 Mathematical Aspects of Adaptive Control
- P-2341 Wave Branching Processes and Invariant Imbedding—I
- P-2361 A Note on Perturbation Series

KALABA, R. E.—continued

- P-2394 Design of Minimal Weight Structures for Given Reliability and Cost
- T-27 A Summary of Known Distribution Functions
- T-48 On the Cauchy Problem for Nonlinear Equations in a Class of Discontinuous Functions
- T-63 The Scattering of Light in Planetary Atmospheres
- T-64 On Amplitude and Phase Pulsations of a Wave Propagating in a Slightly Inhomogeneous Atmosphere

KALISCH, G.

- RM-948 Some Experimental n -Person Games

KALLMANN, H. K. (See also KALLMANN-BIJL, H. K.)

- RM-261 On the Thermodynamics of Solids: Critical Discussion of the Debye and Raman Theories with Applications
- RM-417 Calculation of Specific Impulse and Other Rocket Performance Characteristics
- RM-442 Thermodynamic Properties of Real Gases for Use in High-pressure Problems
- RM-841 Physical Properties of the Upper Atmosphere
- RM-1047 An Investigation of Atmospheric Properties at Great Altitudes
- RM-1500 Scientific Use of an Artificial Satellite
- RM-1505 Estimate of Average Atmospheric Properties between 500 km and 1000 km
- RM-2275 Recent Results of High-altitude Research by Means of Rockets and Satellites
- RM-2286 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- P-120 The Thermodynamic Properties of Boric Oxide and of Aluminum Oxide in the Ideal Gaseous State
- P-261 Physical Properties of the Atmosphere between ~ 80 km and ~ 250 km
- P-532 Relationship between the Masses and Magnitude of Small Meteoroids
- P-542 Quantitative Estimate of Frequency and Mass Distribution of Dust Particles Causing the Zodiacal Light Effect
- P-638 A Study of the Structure of the Ionosphere
- P-733 Scientific Use of an Artificial Satellite
- P-760 Use of an Artificial Satellite in Upper Air Research
- P-835 Physical Properties of the Atmosphere from 90 to 300 Kilometers
- P-1023 Properties of the Atmosphere and Ionosphere between 90 and 300 km
- P-1089 Electron Density Distribution in a New Model of the Ionosphere
- P-1157 A New Model of the Atmosphere and Ionosphere
- P-1553 Cosmic Terrestrial Relations
- P-1564 Upper-atmosphere Properties Based on Rocket and Satellite Data
- P-1591 A Preliminary Model Atmosphere Based on Rocket and Satellite Data
- P-1712 Meteors: Frequency, Size, and Depth of Penetration

KALLMANN-BIJL, H. K. (See also KALLMANN, H. K.)

- P-2126 Variable Atmospheric Properties Derived from Rocket and Satellite Observations
- P-2474 COSPAR International Reference Atmosphere

KAMINS, M.

- R-358 Automatic Checkout Equipment: Employment and Design Considerations
- RM-2578 Determining Checkout Intervals for Systems Subject to Random Failures
- RM-2685 Standardization of Automatic Test and Checkout Equipment: A Preliminary Discussion
- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
- RM-2810-PR Rules for Planned Replacement of Aircraft and Missile Parts
- RM-2810-PR (Abr.) Rules for Planned Replacement of Aircraft and Missile Parts
- P-2563 Planned Replacement
- P-2567 Economic-physical Trade-offs in Scheduling Missile System Checkouts

KANE, M. (INTERNATIONAL BUSINESS MACHINES CORPORATION)

- P-1273 Programming and Modification in the SHARE 709 System

KANTER, H. E.

- RM-2519 A Mathematical Model of the Human External Respiratory System
- P-1811 A Mathematical Model of the Human External Respiratory System

KAO, R. C.

- P-2376 Note on Program Uncertainty in Dynamic Inventory Problem
- P-2463 Aggregation of Magnitude Judgments
- P-2514 Linear Programming

KAPLAN, A.

- RM-37 The Concept of Military Worth
- P-93 The Prediction of Social and Technological Events
- P-187 An Experimental Study of Ambiguity and Context

KAPLAN, L. D.

- P-2213 A New Interpretation of the Structure and CO₂ Content of the Venus Atmosphere

KAPLAN, N. M.

- RM-488 The Law of Value and Soviet Economic Planning
- RM-539 The Choice among Investment Alternatives in Soviet Theory
- RM-735 Capital Investments in the Soviet Union, 1924-1951
- RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan
- RM-1202 Approaches to Soviet Interindustry Relationships
- RM-1443 A Comparison of 1950 Wholesale Prices in Soviet and American Industry
- RM-1692-1 A Comparison of Soviet and American Retail Prices in 1950
- RM-1733 Collective Farm Investment in the USSR
- RM-1906 An Addendum to Previous USSR-U.S. Retail Price Comparisons
- RM-1986 A Comparison of Construction Costs in the USSR and U.S.
- RM-2495 Indexes of Soviet Industrial Output
- P-177 The Choice among Investment Alternatives in Soviet Economic Theory
- P-190 A Book Review of Schlesinger's *Marx, His Time and Ours*
- P-332 Arithmancy, Theomancy, and the Soviet Economy
- P-901 A Comparison of Soviet and American Retail Prices in 1950
- P-1243 Some Methodological Notes on the Deflation of Construction
- P-1398 Comments on Wiles' *Rationality, the Market, Decentralization, and the Territorial Principle*
- P-1848 An Index of Soviet Industrial Output
- P-2248-1 Soviet Capital on January 1, 1960

KARCZ, J. F.

- RM-1930 Soviet Agricultural Marketings and Prices, 1928-1954

KARLIN, S.

- RM-921 A Mathematical Treatment of Learning Models
- RM-933 Decision Processes and Functional Equations
- RM-949 Some Simple Nonlinear Models
- RM-971 Duality in Dynamic Programming
- RM-1316 A Game of Aiming and Evasion
- P-57 Solutions of Discrete, Two-person Games
- P-66 Games with Continuous, Convex Payoff
- P-74 Some Applications of a Theorem on Convex Functions
- P-85 On a Theorem of Ville
- P-97 Geometry of Reduced Moment Spaces
- P-100 Polynomial Games
- P-227 Geometry of Moment Spaces
- P-241 Reduction of Certain Classes of Games to Integral Equations
- P-248 The Theory of Infinite Games
- P-254 On a Class of Games
- P-255 Solutions of Convex Games as Fixed-points
- P-328 A Bayes Model in Sequential Design

KARR, H. W.

- RM-1490 A Preferred Method for Designing a Flyaway Kit
- RM-1803 Base-depot Model Studies
- RM-1890 A Briefing on a Method of Estimating Spare Part Essentiality
- P-748 A Fruitful Application of Static Marginal Analysis
- P-799 The Design of Military Supply Tables for Spare Parts
- P-1064 A Briefing on a Method of Estimating Spare Part Essentiality

KARUSH, W.

- RM-3056-PR On the Maximum Transform and Semigroups of Transformations
- RM-3063-PR Functional Equations in the Theory of Dynamic Programming—XII: An Application of the Maximum Transform
- P-2320 On a New Functional Transform in Analysis: The Maximum Transform

KARZAS, W. J.

- RM-2010-AEC Free-free Gaunt Factors
- RM-2091-AEC Hydrogenic Bound-free Gaunt Factors
- P-1126 Scattering of Light by Protons
- P-1790-AEC Electron Radiative Transitions in a Coulomb Field

KASPER, J. E.

- P-2496 Some Theorems concerning the Motion of an Electrically Charged Particle in a Dipole Magnetic Field

KATZ, A. H.

- P-1707 Observation Satellites: Problems, Possibilities, and Prospects
- P-1718 Introduction to Photographic Instrumentation Engineering
- P-2030 On Style in Research and Development
- P-2432 Hiders and Finders: An Approach to Inspection and Evasion Technology
- P-2439 Comments on an Article by Chas. E. Osgood, "A Psychologist's Cure for the Arms Race"

KAUFMANN, W. W.

- P-886 Policy Objectives and Military Action in the Korean War
- P-1295 The Crisis in Military Affairs

KAWARANTANI, T. K.

- RM-2425 Computing Tetraethyl-lead Requirements in the Linear-programming Format: Notes on Linear Programming and Extensions—Part 52
- P-1545 Computing Tetraethyl Lead Requirements in the Linear Programming Format

KAYSEN, C.

- ★ R-165 Notes on Strategic Air Intelligence in World War II (ETO)
- RM-189 Note on Some Historic Principles of Target Selection
- P-438 The Vulnerability of the United States to Enemy Attack: Elements of an Unclassified Research Program in the Social Sciences
- P-1275 What the Factory Worker Knows about His Factory

KECSKEMETI, P.

- ★ R-308 Strategic Surrender: The Politics of Victory and Defeat
- RM-1948 Political Trends in the Hungarian Army, 1945–1956
- RM-2602 Social Patterns in the Hungarian Revolution
- P-150 Totalitarian Communications as a Means of Control
- P-287 The "Policy Sciences": Aspiration and Outlook
- ★ P-367 Totalitarianism and the Future
- P-430 Sociological Aspects of the Information Process
- P-750 On Reducing Tension
- P-788 The Soviet Approach to International Political Communication
- P-1127 Intellectual Unrest behind the Iron Curtain
- P-1253 The Limits and Problems of "Decompression": The Case of Hungary

★ Indicates publications which are out of print.

- P-2220 Democratic Stability and Instability
- P-2289 Utilization of Social Research in Shaping Policy Decisions
- P-2290 Punishment as Conflict Resolution

KEEN, W., COMDR., USN

- ★ RM-544 A Translation of the Simon Employment Relationship Theory into the Kruskal-Newell Language

KELBER, C. C.

- RM-838 Tabulated Results of Hot Gas Generator Cycle Calculations
- RM-1334 The Effects of Reversed Thrust on Landing Distance
- P-210 The Generalized Approach to the Selection of Propulsion Systems for Aircraft

KELLOGG, W. W.

- RA-15074 Evaluation of Missile Drift Caused by Wind
- R-365 Inquiry into the Feasibility of Weather Reconnaissance from a Satellite Vehicle
- RM-1500 Scientific Use of an Artificial Satellite
- RM-1764 Observations of the Moon from the Moon's Surface
- ★ P-62 Heights of Ionized Regions
- ★ P-67 Turbulence in the Upper Atmosphere
- P-246 Temperatures and Motions of the Upper Atmosphere
- P-259 A Quantitative Analysis of Two Proposed Mechanisms for Vertical Ozone Transport in the Lower Stratosphere
- P-554 Diagram of the Structure of the Upper Atmosphere
- P-733 Scientific Use of an Artificial Satellite
- P-760 Use of an Artificial Satellite in Upper Air Research
- P-822-AEC Close-in Fallout
- P-881-AEC Atomic Cloud Height as a Function of Yield and Meteorology
- P-1091 Atmospheric Transport and Close-in Fallout of Radioactive Debris from Atomic Explosions
- P-1259 Basic Objectives of a Continuing Program of Scientific Research in Outer Space
- P-1335 Space-vehicle Environment
- P-1350 Scientific Exploration in the Fringe of Space
- P-1402 Satellite Weather Reconnaissance
- P-1501 I.G.Y. Rockets and Satellites: A Report on the Moscow Meetings, August, 1958
- P-1619 An Introduction to Do-it-yourself Satellites
- P-1717 Review of I.G.Y. Upper-air Results
- P-1735 Spectral Measurements of Atmospheric Radiation from a Meteorological Satellite
- P-1813 The Upper Atmosphere as Observed with Rockets and Satellites
- P-1876 Upper Atmosphere Studies
- P-2032 Warming of the Polar Mesosphere and Lower Ionosphere in Winter
- P-2120 The Dynamics of the Upper Atmosphere and Its Energy Unbalance
- P-2193 The Upper Atmosphere as Observed with Rockets and Satellites
- P-2227 Rocket Probes in the Upper Atmosphere
- P-2516 Meteorological Rockets Step Upward

KELLY, H. S.

- P-1909 Glossary Lookup Made Easy
- P-1926 MIMIC: A Translator for English Coding

KEMENY, J. G.

- RM-1140 Algebraic Solution of Linear-programming Problems
- P-966 An Experiment in Symbolic Work on the IBM 704

KENDALL, W. B., III

- P-2377-1 Path-invariant Comma-free Codes

KENNEDY, G. C.

- RM-2696-AEC Power Recovery from the Kilauea Iki Lava Pool

★ Indicates publications which are out of print.

KENNEDY, J. L.

- RM-890 The Systems Research Laboratory and Its Program
- RM-1575 The Contextual Map
- P-266 The Uses and Limitations of Mathematical Models, Game Theory, and Systems Analysis in Planning and Problem Solution
- P-272 Some Practical Problems of the Alertness Indicator
- P-447 Experiments on "The Cortical Correlate of Pattern Vision"
- P-653 A Transition Model Laboratory for Research on Cultural Change
- P-657 The Systems Research Laboratory and Its Program
- P-740 The Background and Implications of the Systems Research Laboratory Studies
- P-795 A Simple Model for the Production of the Normal Electroencephalogram
- P-847 Administration of Research in a Research Corporation
- P-965 A Display Technique for Planning
- P-1202 The Systems Research Laboratory's Air-defense Experiments

KENT, A. I.

- P-526 Nonmilitary Applications of Operations Research

KERN, J. W.

- P-2007 Some Consequences of Local Acceleration of Auroral Primaries
- P-2101 Theory of Auroral Morphology

KERSHAW, J. A.

- ★ RM-104 The Economic Strength of the Soviet Union
- RM-336 The Economics of Soviet Agriculture
- RM-367 The Economic War Potential of the United States and the Soviet Union
- RM-2473-FF Systems Analysis and Education
- RM-3009-FF Teacher Shortages and Salary Schedules
- P-109 Productivity and Welfare in Soviet Agriculture
- P-182 The Economic War Potential of the USSR
- P-278 Soviet Agricultural Prospects
- P-737 Recent Trends in the Soviet Economy
- P-1886-FF Decisionmaking in the Schools: An Outsider's View
- P-2201 Directions for Future Growth of the Soviet Economy
- P-2458 What To Do about Teacher Shortages

KESSEL, R. A.

- P-1488 The Meaning and Validity of Inflation-induced Business Profits Resulting from a Lag of Wages behind Prices

KINCAID, H. V. (BUREAU OF APPLIED SOCIAL RESEARCH, COLUMBIA UNIVERSITY)

- RM-1723 The Views of Corporation Executives on the Probable Effect of the Loss of Company Headquarters in Wartime

KIRBY, D. S.

- RM-2567 Summary of Orbital and Physical Data for the Planet Mars
- P-1446 Multiple Image Printing for Planetary Photography
- P-1737 Tables of True Anomaly versus Time Interval for Keplerian Orbits
- P-1738 Fundamentals of Satellite Acquisition Ephemerides
- T-111 The Role of True Absorption in the Atmosphere of Mars

KIRCHHEIMER, O.

- RM-1673-RC West German Trade Unions: Their Domestic and Foreign Policies

KIRKWOOD, R. L.

- RM-1002 The Cost of Unreliability of Air Force Airborne Electronic Equipment as Represented by the Cost of Maintenance

KIRKWOOD, T. F.

- RM-246 A Study To Determine the Flight Paths Which Require Minimum Time and Minimum Fuel for a Typical Present-day Interceptor

★ Indicates publications which are out of print.

- RM-1664 A Brief Investigation of the Possibility of Increasing the Range of Aircraft by Dropping Unnecessary Parts in Flight
- P-1519 A Consideration of Fuels for Future Air Transportation Systems
- P-1539 Supersonic Transports
- P-1575 Some Military Aspects of Supersonic Transports
- P-1979 An Approximate Investigation of the Effect of Boundary Layer Control Pumping on Powerplant Performance

KIVELSON, M. G.

- RM-2899-AEC Quasi-classical Theory of Electron Correlations in Atoms
- RM-3050-PR Collision Damping of Plasma Oscillations
- T-81 The Equation of State of Hydrogen at High Pressures

KLEENE, S. C.

- RM-704 Representation of Events in Nerve Nets and Finite Automata

KLEIN, B. H.

- R-333 Military Research and Development Policies
- P-1054 Application of Operations Research to Development Decisions
- P-1267 What's Wrong with Military R and D?
- P-1916 The Decisionmaking Problem in Development
- P-2147 The Nature and Function of Military R&D

KNAPP, W. J.

- RM-2222 Proposed Non-stoichiometric Ceramics
- RM-2263 On the Linear Relation between the Softening Temperature and the Melting Point of Ceramics
- P-1606 The Linear Relation between the Softening Temperature and the Melting Point of Ceramics
- P-1765 Laminated Metal-Ceramic Composite Materials

KNOX, J. B.

- RM-2108 Graphical Methods for the Quantitative Prediction of Close-in Fallout
- P-1107 The Graphical Integration of the One-parameter Model with Terrain Effects
- P-1108 A Physical Basis for Forecasting the Pressure and Horizontal Wind Fields in the Lower Stratosphere

KOOPMANS, T. C.

- RM-46 Systems of Linear Production Function (Cowles Commission Discussion Papers, Economics, No. 215)
- RM-47 Remarks on Reduction and Aggregation
- P-116 Efficient Allocation of Resources
- P-215 Efficiency Aspects of Dispersal of Population and Industry
- P-352 Activity Analysis and Its Applications
- P-448 The Allocation of Switching Work in a System of Classification Yards

KOTKIN, B.

- RM-2891-PR On the Numerical Solution of a Differential-Difference Equation Arising in Analytic Number Theory
- RM-2907-RC A Mathematical Model of Drug Distribution and the Solution of Differential-Difference Equations
- RM-2978-PR On the Approximation of Curves by Line Segments Using Dynamic Programming—II
- RM-3084-PR Polynomial Approximation: A New Computational Technique in Dynamic Programming—I: Allocation Processes
- RM-3113-PR Some Numerical Results Using Quasilinearization for Nonlinear Two-point Boundary Value Problems
- P-2044 Numerical Investigations of Chemotherapy Models
- P-2154 New Version of a Two-organ Chemotherapy Model
- P-2233 On the Computational Solution of a Class of Nonlinear Differential-Difference Equations

KOUTSOUDAS, A. M.

- RM-2069 Studies in Machine Translation—9: Bibliography of Russian Scientific Articles
P-1241 A Glossary of Russian Physics on Punched Cards

KOZAK, A. S.

- RM-2655 Studies in Machine Translation—12: A Glossary of Russian Physics
T-126 A Comparison of the Theoretically Possible and Actual Procedures Used in Problem Solving
T-133 A Specialized Digital Computer and an Experiment in Its Use (A Computer with Reduced Capabilities)
T-137 A Computer Capable of Learning
T-143 A Probability Model of Perception

KRAMER, J. D. R., JR.

- P-1948 On Control of Linear Systems with Time Lags

KRAMISH, A.

- RM-1711 The Soviet Union and the Atom: The Early Years
RM-1896 The Soviet Union and the Atom: The "Secret" Phase
RM-2163 The Soviet Union and the Atom: Toward Nuclear Maturity
P-307 Spontaneous Fission versus Alpha Decay
P-853 Soviet Atomic Policy
P-1076 The Soviet Atomic Power Program: Large or Small?
P-1134 International Registration of the Atom
P-1283 Science and Doctrine in the Soviet Union
P-1391 Nuclear Energy in the USSR
P-1706 On the Quantization of Meson Mass
P-1711 The Organization of Atomic Energy in the USSR
P-1938 The Peaceful Atom in Retrospect and Prospect
P-1950 The Chinese People's Republic and the Bomb
P-2005 Soviet Atomic Energy

KRASE, W. H.

- RM-2529 Powerplants for Atmospheric and Surface Vehicles on Mars
P-1506 Performance Analysis of Plug Nozzles for Turbojet and Rocket Exhausts
P-1891 Powerplants for Atmospheric and Surface Vehicles on Mars

KRENTEL, W. D.

- P-140 A Simplification of Games in Extensive Form

KRIEGER, F. J.

- RA-15088 A Table of Vibrational Contributions of a Harmonic Oscillator to Thermodynamic Functions
★ R-149 The Composition and Thermodynamic Properties of Air at Temperatures from 500° to 8000°K and Pressures from 0.00001 to 100 Atmospheres
★ R-203 Chemical Kinetics and Rocket Nozzle Design
★ R-311 Behind the Sputniks: A Survey of Soviet Space Science
RM-421 The Thermodynamic Properties of Silicon in the Solid, Liquid, and Gaseous States
RM-490 Lagrangian Interpolation Coefficients and the Calculation of Maxima and Minima and Points of Inflection
RM-646 The Viscosity of Polar Gases
RM-649 Calculation of the Viscosity of Gas Mixtures
RM-1226 Residual Gamma Radiation Hazard after Limited Decontamination Operations
RM-1760 A Casebook of Soviet Astronautics
RM-1922 A Casebook of Soviet Astronautics—Part II
RM-2400 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—I: Hydrogen
RM-2401 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—II: Ammonia

★ Indicates publications which are out of print.

- RM-2402 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—III: Water
- RM-2403 A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—IV: Lithium Hydride
- RM-2807-PR A Parametric Study of Certain Low-molecular-weight Compounds as Nuclear Rocket Propellants—V: Methane
- RM-3053-PR Recent Soviet Advances in Aerospace Technology
- RAOP-2 A Simplified Method for Computing the Equilibrium Composition of Gaseous Systems
- P-120 The Thermodynamic Properties of Boric Oxide and of Aluminum Oxide in the Ideal Gaseous State
- P-237 Chemical Kinetics and Rocket Nozzle Design
- P-1388 The Soviet Ballistic Missile and Space Flight Program
- P-1437 Soviet Astronautics
- P-1562 Soviet Periodical Literature on Astronautics
- P-1647 Future Science and Technology of the USSR
- P-1702 Space Investigation in the USSR: Past, Present, and Future
- P-1954 The Russian Literature on Rocket Propellants
- P-2107 Appraising Soviet Astronautics
- P-2261 Soviet Space Experiments and Astronautics
- T-35 *Red Star Series on Atomic Energy—Part I: Structure and Properties of the Nucleus*
- T-35 *Red Star Series on Atomic Energy—Part II: Radioactive Disintegration of Nuclei*
- T-35 *Red Star Series on Atomic Energy—Part III: Nuclear Reactions*
- T-35 *Red Star Series on Atomic Energy—Part IV: The Physics of a Nuclear Explosion*
- T-35 *Red Star Series on Atomic Energy—Part V: The Thermonuclear Reaction with Hydrogen*
- T-35 *Red Star Series on Atomic Energy—Part VI: Atomic Energy in the Service of the National Economy*
- T-35 *Red Star Series on Atomic Energy—Part VII: The Physics of the Behavior of Nuclear Forces—The Shock Wave*
- T-35 *Red Star Series on Atomic Energy—Part VIII: The Physics of the Behavior of Nuclear Forces—Light Radiation*
- T-35 *Red Star Series on Atomic Energy—Part IX: The Physics of the Behavior of Nuclear Forces—Penetrating Radiation*
- T-35 *Red Star Series on Atomic Energy—Part X: The Physics of the Behavior of Nuclear Forces—Radioactive Substances*
- T-35 *Red Star Series on Atomic Energy—Part XI: The Physics of the Behavior of Nuclear Forces in the Atmosphere and at Sea*
- T-35 *Red Star Series on Atomic Energy—Part XII: The Physics of the Behavior of Nuclear Forces—Radiation Measurements*
- T-36 Chats on the Atomic Weapon
- T-37 On the New American Submarine *Nautilus*
- T-38 Problems of Interplanetary Flights
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part I*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part II*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part III*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part IV*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part V*
- T-41 *Red Star Series on Atomic Weapons and Antiatomic Defense—Part VI*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part I: On the Way to Controlled Nuclear Reactions*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part II: Sources of Nuclear Fuel*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part III: Nuclear Reactors*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part IV: The Nuclear Power Station*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part V: The Nuclear Fuel Engine*
- T-42 *Red Star Series on the Problems of Utilizing Atomic Energy—Part VI: The Atomic Industry—1*

KRIEGER, F. J.—continued

- T-42 *Red Star* Series on the Problems of Utilizing Atomic Energy—Part VII: The Atomic Industry—2
- T-42 *Red Star* Series on the Problems of Utilizing Atomic Energy—Part VIII: The Use of Radioactive Substances in Technology
- T-42 *Red Star* Series on the Problems of Utilizing Atomic Energy—Part IX: Nuclear Radiations and Medicine
- T-44 *Red Star* Series on Guided Missiles—Part I: Construction and Methods of Application
- T-46 *Red Star* on Refueling Aircraft in the Air
- T-50 Soviet Schools in Science: Translation of and Comments on a Russian Literary Gazette Article
- T-55 The Russian Atomic Airplane of the Future
- T-57 On Certain Unsteady Motions of a Compressible Fluid
- T-98 Translations of Two Soviet Articles on Law and Order in Outer Space

KRUEGER, R. W.

- ★ RA-15021 Flight Mechanics of a Satellite Rocket
- ★ RA-15022 Aerodynamics, Gas Dynamics, and Heat Transfer Problems of a Satellite Rocket
- ★ RAOP-1 Analysis and Performance of the Ramjet Engine

KRUSKAL, J. B., JR.

- RM-619 Formulating Precise Concepts in Organization Theory

KUETHE, A. M.

- RM-1972 On the Stability of Flow in the Boundary Layer near the Nose of a Blunt Body

LABINER, K. H.

- RM-2572 The LP-II Data-processing System
- P-1216 Experience in the Use of a Simulation Laboratory in the Design of a Management Information System

LADIN, E.

- P-2445 The Role of the Accountant in Operations Analysis

LANCE, G. N.

- P-852 The Steady, Axially Symmetric Flow of a Viscous Fluid in a Deep Rotating Cylinder Which Is Heated from Below

LANG, H. A.

- RM-1725 Lunar Instrument Carrier: Landing Factors
- RM-2174 Lunar Base Study Jury Report: Evaluation of an Experiment in Creative Design Conducted with College Students
- P-664 A General Transformation for Orthotropic Plane Stress and Plane Strain Problems
- P-832 The Nature of Axisymmetric Wave Fields in Elastic Solids
- P-1141 The Complete Solution for an Elastic Half-space under a Point Step Load
- P-1173 Progress Report on Axisymmetric Wave Fields
- P-1304 Certain Ecological Aspects of a Closed Lunar Base
- P-1433 Some Elementary Facts of Relativity
- P-1498 Surface Displacements in an Elastic Half-space
- P-1505 Dilatational Surface Waves in an Elastic Half-space
- P-1650 The Interpretation and Computation of Axisymmetric Head Waves
- P-1755 On the Rationalization of Certain Complex Elliptic Integrals
- P-2054 A First Estimate of Initial Surface Motions Produced by an Underground Explosion
- P-2215 An Extension of the Karal-Keller Asymptotic Theory of Wave Propagation and Its Application to Explosive Sources
- T-56 The Fluid Half Space under a Mechanical Influence on Its Surface (Two-dimensional Problem)

★ Indicates publications which are out of print.

T-59 The Elastic Half Space under a Mechanical Disturbance of Its Surface (Two-dimensional Problem)

LANGER, P. F.

P-2098 Moscow, Peking, and Japan: Views and Approaches

P-2508 Japan and Her Soviet Neighbor during the Interwar Years: Japanese Images and Reactions

P-2571 The Japanese Communists and Their Struggle for Power

LARMORE, L. E.

RM-793-1 Infrared Radiation from Celestial Bodies

P-523 A Review of Fourier Analysis and Autocorrelation

P-581 A Note on Infrared Stellar Magnitudes

P-897 Atmospheric Transmission

La SALLE, J. P.

RM-197 Application of Theory of Games to Identification of Friend and Foe

RM-212 On Non-zero-sum Games and Stochastic Processes

RM-215 Solutions of a Class of Continuous Games

LATTER, A. L.

R-348 A Method of Concealing Underground Nuclear Explosions

RM-1492-AEC Equation of State of Water

RM-1551 Approximate Values for the Continuous Absorption Coefficient of Air between 2 and 600 Volts

RM-1574-AEC The Equation of State of Water on the Thomas-Fermi Model

RM-1956 Note on the Sr^{90} Hazard

RM-2409 Note on the Strontium-90 Fallout

RM-2562-AEC Concealment of Underground Explosions

RM-2665-AEC The Effect of Plasticity on Decoupling of Underground Explosions

RM-3005-PR The Irrelevance of the GNOME Shot to Decoupling

P-776-AEC The Equation of State of Water on the Thomas-Fermi Model

P-1073-AEC On the Compressibilities of Simple Metals

P-1594 A Seismic Scaling Law for Underground Explosions

P-1759 Transient Effects in the Distribution of Carbon-14 in Nature

P-1782 Carbon-14 Production from Nuclear Explosions

P-2329 The Effect of Plasticity on Decoupling of Underground Explosions

LATTER, R.

★ R-170 Gamma-ray Absorption Coefficients

R-277 Equations of State on the Thomas-Fermi Statistical Model

RM-363 A Class of Integral Equations

RM-372 Asymptotic Solutions for a Class of Integral Equations and Their Application to Neutron Transmission through a Finite Slab

RM-477 A Variable-density Spherical-shock-wave Problem

RM-1208-AEC Hydrogen Wave-functions

RM-1227 Equation of State on the Thomas-Fermi Model—Part I: Non-zero Temperature

RM-1228 Equation of State on the Thomas-Fermi Model—Part II: Zero Temperature without Exchange

RM-1229 Equation of State on the Thomas-Fermi Model—Part III: Zero Temperature with Exchange

RM-1344-AEC Equation of State of Air on the Statistical Model

RM-1416-AEC Atomic Energy Levels for the Thomas-Fermi and Thomas-Fermi-Dirac Potential

RM-1435 A Similarity Solution for a Spherical Shock Wave

RM-1453-AEC Relativistic and Nonrelativistic Energy Levels in Uranium

RM-1492-AEC Equation of State of Water

RM-1574-AEC The Equation of State of Water on the Thomas-Fermi Model

★ Indicates publications which are out of print.

LATTER, R.—continued

- RM-1847-AEC Thomas-Fermi Equation of State for Dilute Gases
- RM-2010-AEC Free-free Gaunt Factors
- RM-2091-AEC Hydrogenic Bound-free Gaunt Factors
- RM-3005-PR The Irrelevance of the GNOME Shot to Decoupling
- P-130 A Class of Integral Equations
- P-147 Gamma-ray Transmission
- P-173 On the Integral Equation $\lambda f(x) = \int_0^a e^{-(x-y)} f(y) dy$
- P-439 Note on the Numerical Treatment of Second-order Differential Equations
- P-544 Asymptotic Solutions for a Class of Integral Equations
- P-585-AEC Atomic Energy Levels for the Thomas-Fermi and Thomas-Fermi-Dirac Potential
- P-633 A Similarity Solution for a Spherical Shock Wave
- P-656 Numerical Solutions of the Thomas-Fermi Statistical Model
- P-667 Temperature Behavior of the Thomas-Fermi Statistical Model for Atoms
- P-776-AEC The Equation of State of Water on the Thomas-Fermi Model
- P-1790-AEC Electron Radiative Transitions in a Coulomb Field
- P-2399 Detection of Nuclear Explosions
- P-2434 The Problem of Detecting Nuclear Explosions

LAUPA, A.

- RM-2998-PR Scabbing in Rock Tunnels

La VALLEE, R. S.

- RM-1360 The Desirability of Revising Aircraft Form 1
- P-2053 The Effect of Maintenance and Reliability on the Operational Effectiveness of an Interceptor Squadron

LAVE, L. B.

- P-2091 An Empirical Description of the Prisoner's Dilemma Game

LAZARSFELD, P. F.

- ★ RM-455 The Use of Mathematical Models in the Measurement of Attitudes

LEEDS, D. J.

- P-1762 Effects of Earthquakes on Tunnels

LEENDERTSE, J. J.

- P-2365 Wave-induced Motions of a Large Rocket Vehicle Drifting in a Vertical Attitude

LEEPER, E. A.

- P-1496 Atmospheric Perturbations of Artificial Satellites

LEHMAN, R. S.

- ★ RM-1125 On Continuous Versions of Dynamic Programming Problems—III: Two Interdependent Industries with No Capacity Constraints
- ★ RM-1126 On Continuous Versions of Dynamic Programming Problems—IV: Duality Theorems for Bottleneck Problems
- RM-1386 On the Continuous Simplex Method
- P-433 A Functional Equation in the Theory of Dynamic Programming and Its Generalizations
- P-436 On the Continuous Gold-mining Equation
- ★ P-492 Studies on Bottleneck Problems in Production Processes
- P-1331 Functional Equations in the Theory of Dynamic Programming—IX: Variational Analysis, Analytic Continuation, and Imbedding of Operators
- P-1332 Functional Equations in the Theory of Dynamic Programming—X: Resolvents, Characteristic Functions, and Values
- P-1906 Dynamic Programming and Gaussian Elimination
- P-2083 Functional Equations in the Theory of Dynamic Programming—XII: Complex Operators and Min-Max Variation
- P-2104 The Reciprocity Formula for Multidimensional Theta Functions

★ Indicates publications which are out of print.

LEIBENSTEIN, H.

- RM-1342 Proposal for the Development of a Theory of Economic Growth for a Soviet-type Economy
P-808 Economic Development and the Rate of Interest under Dictatorial Conditions

LEITES, N. C.

- ★ R-206 The Operational Code of the Politburo
★ R-239 A Study of Bolshevism
RM-371 The Political Meaning of the Kostov Trial in Sofia, Bulgaria, December, 1949
RM-569 Some Useful Passages from Lenin and Stalin
RM-977 Ritual of Liquidation: The Case of the Moscow Trials
RM-1003 The Stalinist Heritage in Soviet Foreign Policy
RM-1004 The Statutes of the Communist Party: Democratic Façade and Totalitarian Reality
RM-1668-RC Paris from EDC to WEU
P-171 Politburo Images of Stalin
★ P-242 The Politburo through Western Eyes
P-408 Stalin as an Intellectual
P-878-RC The *Règle du Jeu* of the French Parliament: As Exemplified in the Election of President Coty
P-2482 Political Negotiation as a Process of Modifying Utilities
P-2542 Notes on a Conference with Soviet Scientists

Le LEVIER, R. E.

- R-348 A Method of Concealing Underground Nuclear Explosions

LEOVY, C. B.

- RM-2951-PR The Effect of Surface Temperature Variations on the Polar Night Jet

LEVIEN, R. E.

- RM-3007-PR Studies in the Theory of Computational Algorithms—1: Formalization, Computability, Representation, and Analysis Problems

LEVIN, E.

- P-1360 Elastic Equilibrium of a Plate with a Reinforced Elliptical Hole
P-1536 Low-thrust Transfer between Circular Orbits
P-1561 Satellite Perturbations Resulting from Lunar and Solar Gravitational Effects
P-1834 Manned Control of Orbital Rendezvous
P-1908 Propulsion Requirements for Rendezvous in Orbit
P-2038 Low-acceleration Transfer Orbits

LEVINE, R. A.

- RM-2086 Baselogs: A Base Logistics Management Game
RM-2374 The Base Maintenance-operations Model Used in RAND Logistics Research
P-1548 A Simulation Model of Air Force Maintenance Operations
P-1552 Random Variations and Sampling Models in Production Economics
P-2025-2 Facts and Morals in the Arms Debate

LEW, R. J.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
RM-66 A Method for the Evaluation of Ramjet Fuels

LEWIS, D. E.

- P-1874 Design and Operation of Ground Guidance Systems

LI, T. Y.

- RM-2523 Similar Solutions of Compressible Laminar-boundary-layer Equations for Binary Mixtures
P-2420 The Effect of Pressure Gradient on the Hypersonic Strong Viscous Interaction on a Flat Plate with Surface Mass Transfer

★ Indicates publications which are out of print.

LEIBHOLD, K. G.

- RAT-1 Optimum Shapes for Axially Symmetrical Supersonic Thrust Nozzles
- RAT-2 Collection of Some German Data on Special Type Landing Gears
- RAT-4 Monograph on the Theory of Characteristics
- RAT-5 Equipment Used To Determine the Effect of Sound and Oscillations on the Human Body
- RAT-6 The Laminar Boundary Layer on a Cone in a Supersonic Air Stream at Zero Angle of Attack
- RAT-7 Approximation of Empirical Functions of Discrete Distribution by Discontinuous Orthogonal Polynomials
- RAT-8 Cones in Supersonic Flow
- RAT-9 Increase in Sensitivity of Amplifiers and Mixers in the Meter and Decimeter Wave Range
- RAT-11 Number of Rounds Required and Destruction Probability in Form of Tables and Graphs
- RAT-12 The Effect of Compressibility on the Laminar Boundary Layer of a Flat Plate
- RAT-13 Propagation of Long Waves around the Earth
- T-15 Some Problems of Flow, Heat Transfer, and Diffusion in the Laminar Flow along a Flat Plate
- T-16 Some Questions of Aerodynamic Damping and Dynamic Stability
- T-17 The Possible Spread of Radioactive Infection by the Fission Products of U^{235}
- T-18 Excerpt from *Motion of Compressible and Incompressible Fluids*
- T-20 Summary of the Status of German Antiaircraft in the Final Phase of World War II
- T-21 On the Spin and the Structure of Electrons

LIESKE, H. A.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- RM-1728 Lunar Instrument Carrier: Trajectory Studies
- P-1022 Accuracy Requirements for Trajectories in the Earth-Moon System
- P-1293 Lunar Trajectory Studies
- P-1441 Circumlunar Trajectory Studies
- P-1453 Lunar Flight Dynamics

LIND, J. R.

- RM-286 Pursuit Path Method: Maneuvering Bomber
- RM-1338 Analytic Formulation of a Theater Air-Ground Warfare System (1953 Techniques)

LINDBLOM, C. E.

- RM-1434-RC Bargaining: The Hidden Hand in Government
- P-1982 Economic Development, Research and Development, Policymaking: Some Converging Views

LINDBLOM, C. R.

- P-1931 Wireline Data Transmission

LINDER, I. W., JR., LT., USN

- RM-1719 Performance of the "Double-threshold" Radar Receiver in the Presence of Interference

LIPP, J. E.

- ★ RA-15006 Status of Satellite Study
- ★ RA-15029 Study of Launching Sites for a Satellite Projectile
- ★ RA-15031 Proposed Type Specification for an Experimental Satellite
- ★ RA-15032 Reference Papers Relating to a Satellite Study

LIPSON, L. S.

- P-1434 Outer Space and International Law
- P-1435 Some Political Implications of the Space Age

★ Indicates publications which are out of print.

LITTLE, J. D.

- P-1375 Use of Mathematical Models for Logistical Planning
- P-2050 An Example of Man-Machine Simulation in Logistics Research
- P-2264-1 Some Suggested Techniques for Data System Development

LIU, T. C.

- P-1590 Structural Changes in the Economy of the Chinese Mainland, 1933 to 1952-1957

LOOFBOUROW, R. L.

- RM-2617 Geological Covering Materials for Deep Underground Installations

LUBELL, H.

- RM-2185 Middle East Crises and World Petroleum Movements
- ★ RM-2385 Survey of Energy and Oil Demand Projections for Western Europe
- RM-2812-PR The Soviet Oil Offensive and Inter-bloc Economic Competition
- P-1170 Israel's National Expenditure: Summary of Results
- P-1382 Book Review: Bruce Netschert, *The Future Supply of Oil and Gas*
- P-1421 Middle East Crises and World Petroleum Movements
- P-1445 Review of OEEC, *Some Aspects of the European Energy Problem*, and OEEC, *Europe's Growing Needs of Energy: How Can They Be Met?*
- P-1461 A Review of OEEC, *Oil: The Outlook for Europe*, and OEEC, *Europe's Need for Oil: Implications and Lessons of the Suez Crisis*
- P-1466 A Review of Energy Forecasts in Western Europe
- P-1682 Review of United Nations, Department of Economic Affairs, *The Development of Manufacturing Industry in Egypt, Israel, and Turkey*
- P-2176 The Public and Private Sectors and Investment in Israel
- P-2209 Energy Policy and Security of Energy Supply in Western Europe
- P-2360 The Soviet Oil Offensive
- P-2524 A Note on the National Accounts of Algeria, 1950-1959 and 1964

LUKE, R. C. (LOCKHEED AIRCRAFT CORPORATION)

- P-693 Semi-automatic Allocation of Data Storage for PACT I

LUSTGARTEN, M. N.

- P-2078 Measurements of Effective Radiated Power

LUTZ, R. J.

- ★ P-205 Applications of Optimum Design Principles to Structural Weight Estimation

LYKODIS, P. S.

- RM-2682-1-PR Theory of Ionized Trails for Bodies at Hypersonic Speeds
- RM-2818-PR The Hypersonic Trail in the Expansion-conduction Region
- P-2244 Ionization Trails

LYNN, H. P., JR.

- P-1878 Main Street, the Moon, and What Next?

MacCLINTOCK, S.

- RM-2858-PR The Nature of Research Goals: Some Necessary Definitions

MADANSKY, A.

- RM-2287 Notes on Linear Programming—Part XLVIII: Inequalities for Stochastic Linear Programming Problems
- RM-2423 Use of Tolerance Limits in Missile Reliability Analysis
- RM-2552 Approximate Confidence Limits for the Reliability of Series and Parallel Systems
- RM-2751 On the Solution of Two-stage Linear Programs under Uncertainty: Notes on Linear Programming and Extensions—Part 55

★ Indicates publications which are out of print.

MADANSKY, A.—continued

- RM-2752 Methods of Solution of Linear Programs under Uncertainty: Notes on Linear Programming and Extensions—Part 56
- P-1236 The Fitting of Straight Lines When Both Variables Are Subject to Error
- P-1289 A Note on "Efficient Estimation and Local Identification in Latent Class Analysis"
- P-1355 On the Maximum Likelihood Estimate of the Correlation Coefficient
- P-1358 Least Squares Estimation in Finite Markov Processes
- P-1418 Bounds on the Expectation of a Convex Function of a Multivariate Random Variable
- P-1423 Use of Tolerance Limits in Missile Evaluation
- P-1538 Determinantal Methods in Latent Class Analysis
- P-1596 Some Results and Problems in Stochastic Linear Programming
- P-1600 Inequalities for Stochastic Linear-programming Problems
- P-1644 Partitioning Methods in Latent Class Analysis
- P-1806-1 Parameter-free and Nonparametric Tolerance Limits: The Exponential Case
- P-1939 Use of the "Expected Value Solution" in Linear Programming under Uncertainty
- P-2039 On the Solution of Two-stage Linear Programs under Uncertainty
- P-2132 Methods of Solution of Linear Programs under Uncertainty
- P-2325 Tests of Homogeneity for Correlated Samples
- P-2401 Approximate Confidence Limits for the Reliability of Series and Parallel Systems

MADDEN, J. D.

- P-216 The Combomat
- P-505 A Note concerning the Organization of an IBM Type 701 Installation

MAH, F.

- P-2031-RC The Financing of Public Investment in Communist China

MALCOLM, D. G.

- P-1056 On the Construction of a Multi-stage, Multi-person Business Game

MALLET, J. D.

- RM-1029 Transmission of Pulses over Voice-quality Telephone Lines
- RM-1238 Detection Range of an Active Radar Seeker

MANHEIM, R.

- RM-2170-RC Attitudes of the French Parliament and Government toward Atomic Weapons

MANN, I.

- RM-1829 Techniques of Systems Analysis
- RM-1880 Graphs of Partial Sums of the Binomial Distribution
- RM-1937 Ten Common Pitfalls
- RM-2651 Values of Large Games—IV: Evaluating the Electoral College by Montecarlo Techniques
- P-1165 Monte Carlo
- P-1166 Game Theory
- P-1167 War Gaming

MANNE, A. S.

- RM-1612 Allocating MATS Equipment with the Aid of Linear Programming
- RM-1658 The Allocation of MATS Airlift—January, 1956: Pacific Ocean Area
- RM-1757 A Linear Programming Model of the U.S. Petroleum Refining Industry
- RM-1785 Costs and Benefits in Mathematical Programming
- P-383 Concave Programming for Gasoline Blends
- P-468 Notes on Parametric Linear Programming
- P-479 A Motor Gasoline Blending Problem
- P-481 Petroleum Refinery Operations Scheduling—Chapter II: Conventional Methods of Refinery Economic Analysis
- P-484 Petroleum Refinery Operations Scheduling—Chapter III: A Crude Oil Allocation Problem
- P-487 Petroleum Refinery Operations Scheduling—Chapter V: A Gasoline Blending Problem

- P-489 Petroleum Refinery Operations Scheduling—Chapter IV: A Naphtha Reforming Problem
- P-493 Petroleum Refinery Operations Scheduling—Chapter VI: Cracking, Recycling, and Blending—An Integrated Refinery Problem
- P-502 Petroleum Refinery Operations Scheduling—Chapter I: Introduction
- P-503 Petroleum Refinery Operations Scheduling—Chapter VII: The Economist and the Operations Scheduler
- P-533 Air Cargo Transport Scheduling: An Illustrative Block Triangular System
- P-563 A Linear Programming Model of the U.S. Petroleum Refining Industry
- P-711 On the Solution of Discrete Programming Problems
- P-936 Costs and Benefits in Mathematical Programming

MANSON, W.

- P-2565 Physicochemical Characteristics of Placental Transfer

MARCUM, J. I.

- RM-50 Tables of Integrals Associated with the Error Function of a Complex Variable
- ★ RM-339 Table of Q Functions
- RM-753 A Statistical Theory of Target Detection by Pulsed Radar: Mathematical Appendix
- RM-754 A Statistical Theory of Target Detection by Pulsed Radar
- RM-2556 Neutron Fluxes in Air: A Comparison of Monte Carlo Code Computations by RAND, Los Alamos, and Sandia
- P-90 Tables of Hermite Polynomials and the Derivations of the Error Function

MARCUS, M. B.

- RM-2375 Analysis of the "Delay and Comparison Circuit" for Radar Receivers in the Presence of Interference
- P-1201 Sequential Decision Problems with a Limited Memory
- P-1228 The Utility of a Communication Channel and Applications to Suboptimal Information-handling Procedures
- P-1673 Recurrent Events in a Bernoulli Sequence
- P-2186 The Compression of Finite Discrete Messages
- P-2423 Sequential Detection in Radars with Multiple Resolution Elements

MARGENAU, H.

- RM-1487-AEC Line Broadening by Electrons: The Validity of Simple Theories
- RM-1669 Estimate of Pressure Effects on NO-band Lines
- RM-1670-AEC The Validity of the Statistical Theory of Pressure Broadening
- RM-1779-AEC Stark Effects in Line Broadening
- P-672 Line Broadening by Electrons: The Validity of Simple Theories

MARGOLIS, M. A.

- P-1589 Economic Considerations of Space Flight Ground Support Requirements
- P-1639 Sources, Availability, and Estimated Costs of Propellants
- P-1975 Economic Aspects of Developing and Orbiting a Space Station

MARKOWITZ, H. M.

- R-318 A Time Series Analysis of Interindustry Demands
- RM-951 The Problem of Defining and Measuring Railroad Capacity
- RM-954 On Predicting a Combination of Outputs and Final Demands by Input-Output
- RM-1085 Process Analysis of the Metal-working Industries
- ★ RM-1254 The Nature and Applications of Process Analysis
- RM-1263 The Geographic Distribution of Metal-working Equipment
- RM-1438 The Optimization of Quadratic Functions Subject to Linear Constraints
- RM-1452 Notes on Linear Programming—Part XXV: The Elimination Form of the Inverse and Its Application to Linear Programming
- RM-1470 Notes on Linear Programming—Part XXIV: The Modification of the Right-hand Side of a Linear Programming Problem
- RM-1512 An Analysis of Machine Tool Substitution Possibilities

★ Indicates publications which are out of print.

MARKOWITZ, H. M.—continued

- P-547 The Nature and Applications of Process Analysis
- P-600 Industry-wide, Multi-industry, and Economy-wide Process Analysis
- P-602 Concepts and Computing Procedures for Certain X_{ij} Programming Problems
- P-637 The Optimization of a Quadratic Function Subject to Linear Constraints
- P-680 The Elimination Form of the Inverse and Its Application to Linear Programming
- P-711 On the Solution of Discrete Programming Problems

MARKS, B. J.

- P-2435 Status Prediction of Scheduled Equipment

MARKS, S. L.

- P-2197 The Nature of Data in Language Analysis
- P-2552 A One-day Look at Computing

MARON, M. E.

- RM-2601 Automatic Indexing: An Experimental Inquiry
- RM-3011-PR Mechanisms Underlying Predictive Behavior for an Intelligent Machine
- P-2180 Automatic Indexing: An Experimental Inquiry
- P-2279 A Logician's View of Language Data Processing
- P-2455 Information Retrieval: A Look at the Logical Framework and Some New Concepts
- P-2471 Probability and the Library Problem
- P-2572 Design Principles for an Intelligent Machine

MARSCHAK, J.

- P-189 Optimal Inventory Policy
- P-470 Notes on the Optimal Choice of Weapons

MARSCHAK, T. A.

- RM-2205 A Spatial Model of U.S. Petroleum Refining
- P-649 An Activity Analysis Approach to Location Theory
- P-1015 On Gradient Methods for Approaching Constrained Maxima
- P-1587 Centralization and Decentralization in Economic Organizations
- P-1871 Theory and Policy in the French Nationalized Industries
- P-1901-RC Strategy and Organization in a System Development Project

MARSHALL, A. W.

- ★ R-157 The Frequency of Mental Disease: Long-term Trends and Present Status
- RM-271 A Note on the Power Function of the Wald-Wolfowitz Tolerance Limits for a Normal Distribution
- RM-787 A Simplified Study of Reconnaissance in Strategic Bombing Campaigns
- P-70 The Conditional Expectancy of Mental Disease
- P-133 Some Tests for Comparing Percentage Points of Two Arbitrary Continuous Populations
- P-179 A Large Sample Test of the Hypothesis That One of Two Random Variables Is Stochastically Larger than the Other
- P-243 Comment on H. J. Barnett's *Specific Industry Output Projections*
- P-311 An Application of Markov Processes to the Study of the Epidemiology of Mental Disease
- P-337 Methods of Reducing Sample Size in Monte Carlo Computations
- P-420 The Supply of Female Labor in World War II
- P-531 The Use of Multistage Sampling Schemes in Monte Carlo Computations
- P-725 A Note on Randomized Branch Sampling
- P-756 An Introductory Note for the Proceedings of the Gainesville, Florida, Symposium on Monte Carlo Methods
- P-1077 The Small Sample Distribution of $n\omega_n^2$
- P-1174 Experimentation by Simulation and Monte Carlo
- P-1821 Predictability of the Costs, Time, and Success of Development

★ Indicates publications which are out of print.

MARSHALL, S. M.

RM-1091 A Review of the Steel Industry of the United States

MARTIN, H. G.

P-719 Conclusions after Using the PACT-1 Advanced Coding Technique

MARTINELLI, E. A.

R-348 A Method of Concealing Underground Nuclear Explosions

RM-2665-AEC The Effect of Plasticity on Decoupling of Underground Explosions

P-1594 A Seismic Scaling Law for Underground Explosions

P-2329 The Effect of Plasticity on Decoupling of Underground Explosions

MASON, R. J.

P-2062-RC The Future of Data Processing in State Government

P-2492 Data Processing for Cities

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

★ RM-1163 Communication and Learning in Task-oriented Groups

MASSELL, B. F.

RM-2844-PR Postattack Damage Assessment: A Conceptual Analysis

RM-2952-PR Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities

P-2088-2 Is Investment Really Unimportant?

P-2089-3 Research and Economic Growth: The Role of Public Policy

P-2090-2 A Disaggregated View of Technical Change

P-2103 Some Observations on Capital Longevity

P-2149 Investment, Innovation, and Growth

P-2194-RC Another Small Problem in the Analysis of Growth

P-2274-1 Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities

P-2510 Determinants of Productivity Change in United States Manufacturing

MASSON, D. J.

R-339 Aerodynamics of the Upper Atmosphere

RM-1693 Skin Temperature Variation during Re-entry of Scientific Satellite

RM-1735 Surface-protection and Cooling Systems for High-speed Flight

RM-1844 A Recoverable Scientific Satellite

RM-2516 A Review of Binary Boundary Layer Characteristics

RM-2678 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow

P-829 Surface-protection and Cooling Systems for High-speed Flight

P-958 A Recoverable Scientific Satellite

P-1119 Recovery of a Circum-lunar Instrument Carrier

P-1371 General Characteristics of Binary Boundary Layers with Applications to Sublimation Cooling

P-1729 A Review of Binary Boundary Layer Characteristics

P-1730 Effect of Molecular Weight on Mass-transfer Cooling in a Laminar Boundary Layer on a Flat Plate

P-1732 Mass-transfer Cooling in a Turbulent Boundary Layer

P-2110 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow

MATHEMATICS DEPARTMENT (Formerly known as the Mathematics Division)

R-234 Offset Circle Probabilities

RM-594 The Combomat: Customer-programmed IBM Calculation

★ RM-950 List of Unclassified Mathematics Division Publications, Including Related Reports from Other Divisions

MATHEWS, J.

RM-2665-AEC The Effect of Plasticity on Decoupling of Underground Explosions

RM-2686-AEC Static Deformation of a Plastic Medium

P-2329 The Effect of Plasticity on Decoupling of Underground Explosions

★ Indicates publications which are out of print.

MATTHES, T. K.

- P-2541 On the Optimality of Sequential Probability Ratio Tests

MATTHEWS, A. T.

- P-2109 Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium

MAYBERRY, J. P.

- P-222 A Comparison of Treatments of a Duopoly Situation

MEAD, M.

- ★ R-199 Soviet Attitudes toward Authority

MECKLING, W. H.

- R-333 Military Research and Development Policies
P-1054 Application of Operations Research to Development Decisions
P-1516 Single Ownership of a Superior Resource: The Road Case Again Re-examined
P-1821 Predictability of the Costs, Time, and Success of Development
P-2147 The Nature and Function of Military R&D
P-2216 The Economic Potential of Communication Satellites
P-2396 Economic Aspects of Communication Satellite Systems

MELAHN, W. S.

- RM-525 RAND REAC Manual
P-197 Modifications of the RAND REAC
P-686 A Description of a Cooperative Venture in the Production of an Automatic Coding System

MELNIK, C.

- RM-2170-RC Attitudes of the French Parliament and Government toward Atomic Weapons
P-878-RC The *Règle du Jeu* of the French Parliament: As Exemplified in the Election of President Coty

MENDERSHAUSEN, H.

- RM-2175 Agriculture in Communist Germany
RM-2305 Terms of Trade between the Soviet Union and Smaller Communist Countries, 1955 to 1957
RM-2414 Dependence of East Germany on Western Imports
RM-2507-1-PR The Terms of Soviet Satellite Trade: A Broadened Analysis
RM-2767 Spare Parts Inventories for NATO
P-1159 Economic Problems in Air Force Logistics
P-1598 Terms of Trade between the Soviet Union and Smaller Communist Countries, 1955 to 1957
P-1793 A New Book on East German Trade
P-1873 The Terms of Soviet Satellite Trade: A Broadened Analysis
P-2544 Mutual Price Discrimination in Soviet Bloc Trade

MENGEL, A. S.

- ★ RA-15028 Communication and Observation Problems of a Satellite
RM-226 Principles of the REAC
★ RM-236 Summary of REAC Experience
RM-517 Expected Results of a Bombing Strike, Including Reconnaissance
RM-522 Curves Giving Expected Results of a Bombing Strike
RM-525 RAND REAC Manual
RM-635 Hours of Darkness at Altitude
RM-1068 Optimum Tactics in an Air Superiority Campaign
RM-1379 Optimization in Dynamic Allocation Problems by a Modified Calculus of Variations Technique
P-199 Optimum Trajectories

MENZEL, D. H.

- RAOP-3 The G-Layer of the Ionosphere

- ★ Indicates publications which are out of print.

MERTZ, P.

- RM-3024-PR Error Burst Chains in Data Transmission
- P-1761 Model of Impulsive Noise for Data Transmission
- P-1775 The Effect of Delay Distortion on Data Transmission
- P-1983 Model of Error Burst Structure in Data Transmission
- P-2105 Statistics of Hyperbolic Error Distributions in Data Transmission

MESTHENE, E. G.

- R-333 Military Research and Development Policies
- RM-2858-PR The Nature of Research Goals: Some Necessary Definitions
- RM-2915-PR The Titanium Decade
- P-2147 The Nature and Function of Military R&D
- P-2462-1 Science and Statecraft

MEYER, J. R.

- RM-2878-FF A First Approximation to a RAND Model for Study of Urban Transportation

MEYER, K. H.

- RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design

MEYEROTT, R. E. N.

- RM-1487-AEC Line Broadening by Electrons: The Validity of Simple Theories
- RM-1554 Absorption Coefficients of Air from 6000°K to 18,000°K
- RM-1578-AEC Photoelectric K and L Shell Absorption Coefficients for Highly Ionized Atoms
- P-672 Line Broadening by Electrons: The Validity of Simple Theories
- P-732 Line Width Problems in Hot, Dense Atmospheres
- P-872-AEC Photoelectric K and L Shell Absorption Coefficients for Highly Ionized Atoms

MICHELSON, I.

- RM-1038 The Normal Force and Pressure Distribution on a Flat Plate at Normal Incidence, in the Presence of a Moving Vortex Pair

MICKEY, M. R.

- RM-857 A Model for Partial Damage to Point Targets
- P-470 Notes on the Optimal Choice of Weapons
- P-1348 Some Finite Population Unbiased Ratio and Regression Estimators
- P-1376 A Method for Determining Supply Quantity for the Case of Poisson Distribution of Demand

MICKS, W. R.

- R-172 Structural Weight Analysis: Fuselage and Shell Structures
- R-198 Structural Weight Analysis: Wing Weight Equations
- ★ RM-391 Derivation of a Wing Weight Formula for a Thin Wing Structure
- RM-1518 A Test Program for Obtaining Basic Data on Creep-buckling Strength of Flat Plate Elements at Elevated Temperature
- RM-2201 A Proposed Method for Obtaining Ductility in Beryllium by the Use of a Composite Arrangement
- RM-2304 Bibliography of Literature on Optimum Design of Structures and Related Topics
- P-89 Minimum Weight of Stiffened Cylindrical Shells in Pure Bending
- P-124 Effect of Torsional Stiffness Requirements on Wing Structural Weight
- P-361 A Method of Estimating the Compressive Strength of Optimum Sheet-stiffener Panels for Arbitrary Material Properties, Skin Thickness, and Stiffener Shapes
- P-498 A Method for Determining the Effects of Elevated Temperature on Structural Design and Weight
- P-1999 On University Courses in Materials for the Engineer
- P-2366 Improving the Mutual Guidance and Support between the Fields of Materials and Design

MIDDLETON, D.

- RM-1770 On the Detection of Stochastic Signals in Additive Normal Noise—Part I

★ Indicates publications which are out of print.

MIDDLETON, D.—continued

- RM-2124 A Comparison of Random and Periodic Data Sampling for the Detection of Signals in Noise
RM-2625 Some Results on New Classes of Matched Filters
P-1050 On the Detection of Stochastic Signals in Additive Normal Noise—Part I
P-1642 A Comparison of Random and Periodic Data Sampling for the Detection of Signals in Noise
P-1973 Dynamic Programming, Sequential Estimation, and Sequential Detection Processes

MILLIMAN, J. W.

- P-2252 Decision Making for Public Investment: Discussion

MILNOR, J. W.

- RM-654 Sums of Games
RM-675 Axioms for Measurable Utility
RM-679 Games against Nature
RM-916 Reasonable Outcomes for n -Person Games
RM-936 An Experiment in Mental Generation of Random Numbers
RM-948 Some Experimental n -Person Games
RM-2649 Values of Large Games—II: Oceanic Games
P-319 An Axiomatic Approach to Measurable Utility
P-622 On Games of Survival

MINTZ, Y.

- P-2003 Temperature and Circulation of the Venus Atmosphere

MIRKOVICH, A. R.

- RM-1357 Confidence Intervals for Poisson Parameters in Logistics Research
RM-1640 The Relation of Aircraft Status Data to the Logistics System

MITCHELL, H. H., M.D.

- RM-2500 An Evaluation of the Human Retinal Burn Problem Arising from Atomic Detonations
RM-2801-PR Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint
P-1683-RC A Discussion of *Report on a Study of Non-Military Defense*
P-1927 Lecture on Civil Defense
P-2009 Time and Civil Defense
P-2413 Ecological Problems and Postwar Recuperation: A Preliminary Survey from the Civil Defense Viewpoint

MIZUKI, M.

- P-1226 On the Computational Determination of the Nature of Solutions of Nonlinear Systems with Stochastic Inputs

MODESITT, G. E.

- RM-3096-PR Idealized Sheath Theory and Satellite Charge-up in the Van Allen Region

MOHR, D. V.

- RM-2065 Studies in Machine Translation—4: Manual for Pre-editing Russian Scientific Text
RM-2066-1 Studies in Machine Translation—6: Manual for Coding Russian Grammar

MONCREIFF, B.

- P-759 An Automatic Supervisor for the IBM 702

MOOD, A. M.

- RM-111 An Asymptotic Distribution for a Mortality Problem
P-280 On the Asymptotic Efficiency of Certain Nonparametric Two-sample Tests
P-579 Gaming as a Technique of Analysis
P-899 War Gaming as a Technique of Analysis

MOORE, F. T.

- P-1099 Regional Science Techniques Applicable to Regional Planning

- P-1313 Criminal Jurisdiction in Overseas Areas
- P-1411 The Failures of the World Bank Missions
- P-1904 Economic Development and the Employment of Resources
- P-2287 Economic Growth and Foreign Aid: A Proposal concerning the Export of Industrial Plants
- P-2342-1 On Regional Development and Dynamic Models
- P-2469 Studies in Economic Planning: A Trip Report
- P-2533 Urban Economic Accounts and Research: A Comment

MOORE, L. L.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- RM-144 Aerodynamic Heating Relations
- P-50 A Solution of the Laminar Boundary Layer Equations for a Compressible Fluid with Variable Properties Including Dissociation

MOORSTEEN, R. H.

- RM-1037 Prices of Road Building and Construction Machines, USSR, 1928-1949
- RM-1121 Prices of Tractors Trucks, and Automobiles, USSR, 1928-1949
- RM-1225 Prices of Prime Movers, USSR, 1927/28-1949
- RM-1258 Prices of Railroad Rolling Stock, USSR—1927/28-1949
- RM-2495 Indexes of Soviet Industrial Output
- P-1298 Economic Prospects for Communist China
- P-1397 Comments on *Technological Policy and Economic Calculation in Soviet Industry*, by David Granick
- P-1578 An Economic Development of Strategic Significance in Communist China
- P-1739 Review of Choh-ming Li's *Economic Development of Communist China* (Berkeley, 1959)
- P-1848 An Index of Soviet Industrial Output
- P-2119 On Measuring Productive Potential and Relative Efficiency

MORGENSTERN, O.

- RM-614 Note on the Formulation of the Study of Logistics
- RM-734 Prolegomena to a Theory of Organization
- RM-1296 Consistency Problems in the Military Supply System
- RM-1325 The Compressibility of Organizations and Economic Systems
- P-2169 Symmetric Solutions of Some General n -Person Games

MORRIS, H.

- RM-794 Bacteria
- RM-2678 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow
- P-2110 Measurements of Sphere Drag from Hypersonic Continuum to Free-molecule Flow

MOSZKOWSKI, S. A.

- RM-1578-AEC Photoelectric K and L Shell Absorption Coefficients for Highly Ionized Atoms
- RM-2610-AEC Some Statistical Properties of Level and Line Distributions in Atomic Spectra
- RM-2776-AEC The Mössbauer Effect
- RM-2947-AEC On the Energy Distribution of Terms and Line Arrays in Atomic Spectra
- P-872-AEC Photoelectric K and L Shell Absorption Coefficients for Highly Ionized Atoms

MULHOLLAND, R. P.

- ★ RM-1072 The Rate of Advance of the Front Line in Some World War II Campaigns

MULLIKIN, T. W.

- RM-2693 Neutron Branching Processes
- RM-2869-PR Limiting Distributions for Critical Multitype Branching Processes with Discrete Time
- RM-2917-PR Estimates of Critical Dimensions of Spherical and Slab Reactors
- RM-3027-PR A Complete Solution of the X and Y Equations of Chandrasekhar
- P-1422 Semigroups of Class (C_0) in L_p Determined by Parabolic Differential Equations

★ Indicates publications which are out of print.

MULLIKIN, T. W.—continued

- P-1781 On the Increase of Convergence Rates of Relaxation Procedures for Elliptic Partial Difference Equations
- P-1985 Neutron Branching Processes
- P-2150 Criticality Estimates for Spheres and Slabs
- P-2211 Principles of Invariance in Transport Theory
- P-2232 Operators Commuting with Translation by One—Part I: Representation Theorems
- P-2253-1 Estimates of Critical Dimensions of Spherical and Slab Reactors
- P-2305 Limiting Distributions for Critical Multitype Branching Processes

MYERS, H. A.

- RM-2764 Industrial Equipment Spectrum Signatures
- P-645 Radiation Patterns of Unsymmetrically Fed Prolate Spheroidal Antennas
- P-1750 Radar Signal Density Predictions and Measurements

McCALL, J. J.

- RM-2810-PR Rules for Planned Replacement of Aircraft and Missile Parts
- RM-2989-PR Solution of a Simple Overhaul Problem
- RM-3014-PR When To Stop Sampling and Initiate Product Improvement
- P-1905 Differences between the Personal Demand for Money and the Business Demand for Money

McGARVEY, D. C.

- RM-2906-PR Operators Commuting with Translation by One—Part II: Differential Operators with Periodic Coefficients
- P-1503 Operators Commuting with Translation by One
- P-2138 Problems of Force Posture Evaluation
- P-2232 Operators Commuting with Translation by One—Part I: Representation Theorems
- P-2297 Linear Differential Systems with Periodic Coefficients Involving a Large Parameter

McGLOTHLIN, W. H.

- RM-2086 Baselogs: A Base Logistics Management Game
- RM-2177 The Simulated Aircraft and Its Failure Model in LP-I
- RM-2451 A Model for Assessing the Effect of Maintenance on Missile Launch Probability
- RM-2536 The Use of Bayesian Techniques for Predicting Spare-parts Demand
- RM-2701 Application of the Bayes Technique to Spare-parts Demand Prediction
- P-1454 The Simulation Laboratory as a Developmental Tool
- P-1696 An Analytical Model for Developing Optimal Ballistic Missile Maintenance Procedures

McGRATH, H. T., JR.

- P-416 The EIP: An External and Internal Program Setup for IBM's Model II CPC

McGUIRE, C. B.

- RM-1488 Studies in the Economics of Transportation
- RM-1592 Steam Locomotive Availability and Terminal Facilities
- ★ P-308 Activity Analysis and the Prediction of Traffic Flows
- P-437 The Determination of Traffic in a Road Network: An Economic Approach
- P-448 The Allocation of Switching Work in a System of Classification Yards
- P-1138 Intercontinental Military Air Transport: An Application of a Model for the Study of Aircraft Procurement Policies
- P-1828 Peak Loads and Efficient Pricing: A General Solution and a Practical Approach

McKEAN, R. N.

- R-346 The Economics of Defense in the Nuclear Age
- RM-2473-FF Systems Analysis and Education
- RM-3009-FF Teacher Shortages and Salary Schedules
- P-301 Are We Sure about Dispersal?
- P-386 Suboptimization Criteria and Operations Research
- P-548 Is Dispersal Good Defense?
- P-689-RC Criteria for the Selection of Water-resource Projects

★ Indicates publications which are out of print.

- ★ P-999-RC Operations Research and Government Budgets
- P-1180-RC Criteria of Efficiency in Government Expenditures
- P-1275 What the Factory Worker Knows about His Factory
- P-1602 Evaluating Alternative Expenditure Programs
- P-1886-FF Decisionmaking in the Schools: An Outsider's View
- P-2155 What Can Managerial Economics Contribute to Economic Theory?
- P-2458 What To Do about Teacher Shortages

McKINSEY, J. C. C.

- ★ R-228 Introduction to the Theory of Games
- RM-31 Ville's Example of a Game without a Strategic Saddle-point
- RM-386 "Best" Strategies
- P-47 Isomorphism of Games, and Strategic Equivalence
- P-140 A Simplification of Games in Extensive Form

McMILLAN, N. C.

- T-21 On the Spin and the Structure of Electrons

McMILLAN, W. G.

- R-348 A Method of Concealing Underground Nuclear Explosions
- RM-1537-AEC Crystal Structures and Atomic Volumes of the Elements
- RM-1793-AEC Thermodynamic Properties of Mixtures on the Statistical Model
- RM-2665-AEC The Effect of Plasticity on Decoupling of Underground Explosions
- RM-3005-PR The Irrelevance of the GNOME Shot to Decoupling
- P-927-AEC Thermodynamic Properties of Mixtures on the Statistical Model
- P-1073-AEC On the Compressibilities of Simple Metals
- P-1266-AEC Approximate Compressibilities of Elements on the Statistical Model
- P-2329 The Effect of Plasticity on Decoupling of Underground Explosions

McNEILL, R. B.

- RM-1417 A Proposal for a New Air Force Supply Procedure

NAGATA, T. (UNIVERSITY OF TOKYO)

- P-1121 Ionospheric Electric-current Systems Derived Using International Polar Year Data

NASH, C. P.

- RM-1511-AEC Abstract Compendium on Theoretical Equation of State for Solids

NASH, J. F.

- RM-615 n -Person Games: An Example and a Proof
- RM-948 Some Experimental n -Person Games
- RM-1326 Continuous Iteration Method for Solution of Differential Games
- RM-1361 Parallel Control
- P-172 Two-person Cooperative Games
- P-222 A Comparison of Treatments of a Duopoly Situation

NEISWENDER, R. L.

- P-1837-1 Guide to Russian Reference and Language Aids: An Annotated Bibliography
- P-1919 Soviet Scientific and Technical Literature: Sources and Availability
- P-2491 Russian Transliteration: Sound and Sense
- T-117 Advances in Meteorite Research

NELSON, H. W.

- RM-1417 A Proposal for a New Air Force Supply Procedure
- RM-1754 A Revised Data-processing System for Managing War Reserve Stocks of Aircraft Spare Parts

★ Indicates publications which are out of print.

NELSON, R. R.

- RM-2146 The Economics of Invention: A Survey of the Literature
- RM-2482 The Economics of Parallel R and D Efforts: A Sequential-decision Analysis
- P-1288 The Simple Economics of Basic Scientific Research: A Theoretical Analysis
- P-1537 Growth Models and the Escape from the Low-level Equilibrium Trap: The Case of Japan
- P-1604 The Economics of Invention: A Survey of the Literature
- P-1687 Uncertainty Prediction, and Competitive Equilibrium
- P-1774 The Economics of Parallel R and D Efforts
- P-1854-RC The Link between Science and Invention: The Case of the Transistor
- P-1971 A Note on Stability, and the Behavior Assumptions of Harrod-type Models
- P-2073-RC Introduction to the UNBER-SSRC Conference Volume on Inventive Activity
- P-2089-3 Research and Economic Growth: The Role of Public Policy

NERING, E. D.

- RM-948 Some Experimental n -Person Games

NEUBERGER, E.

- P-2203 The Economics of Compensating Balances

NEWELL, A.

- RM-555 The Capacity of a Railroad Freight Yard (A Survey of the Problem—Not a Solution)
- RM-619 Formulating Precise Concepts in Organization Theory
- RM-890 The Systems Research Laboratory and Its Program
- RM-2506 The Simulation of Human Thought
- P-291 An Example in the Theory of Organization
- P-620 The Chess Machine: An Example of Dealing with a Complex Task by Adaptation
- P-659 Description of the Air-defense Experiments—II: The Task Environment
- P-850 Current Developments in Complex Information Processing
- P-868 The Logic Theory Machine: A Complex Information Processing System
- P-951 Empirical Explorations of the Logic Theory Machine: A Case Study in Heuristics
- P-954 Programming the Logic Theory Machine
- P-971 Elements of a Theory of Human Problem Solving
- P-987 Problem Solving in Humans and Computers
- P-1202 The Systems Research Laboratory's Air-defense Experiments
- P-1277 A Command Structure for Complex Information Processing
- P-1319 Chess-playing Programs and the Problem of Complexity
- P-1320 The Processes of Creative Thinking
- P-1584 Report on a General Problem-solving Program
- P-1708 What Have Computers To Do with Management?
- P-1734 The Simulation of Human Thought
- P-1742 A Variety of Intelligent Learning in a General Problem Solver
- P-1929 An Introduction to Information Processing Language—V
- P-1946 On Programming a Highly Parallel Machine To Be an Intelligent Technician
- P-2142 New Areas of Application of Computers
- P-2257 GPS: A Program That Simulates Human Thought
- P-2276 Computer Simulation of Human Thinking
- P-2312 Computer Simulation of Human Thinking and Problem Solving

NEWELL, H. E., JR.

- P-835 Physical Properties of the Atmosphere from 90 to 300 Kilometers

NICHOLS, R. T.

- RM-346 The German Munitions Production Index: World War II
- P-2388 The European Coal and Steel Community

NIEDERCORN, J. H.

- P-2468-1 A Macro Investment Model for Manufacturing

NIMITZ, A. E.

- RM-804 A Dollar Index of Soviet Petroleum Output, 1927–28 to 1937

- RM-1042 A Dollar Index of Soviet Coal Output, 1927/28-1937
- RM-1055 A Dollar Index of Soviet Iron and Steel Output, 1927/28-1937
- RM-1178 The New Soviet Agricultural Decrees (September Plenum, 1953)
- RM-1250 Statistics of Soviet Agriculture
- RM-1497 Prices of Refined Petroleum Products in the USSR, 1928-1950
- RM-1552 Soviet Agriculture since the September, 1953, Reforms
- RM-2101 Soviet National Income and Product, 1949-1955
- RM-2326 Soviet Statistics of Meat and Milk Output: A Note on Their Comparability over Time
- T-39 Diffusion of Meteoric Trails

NISKANEN, W. A.

- P-1621-RC Proposal for a "Smog Tax"
- P-1690 A Macro Analysis of Military Air Transportation
- P-1826 A Structural Approach to Military Air Transportation
- P-1872 Taxation and the Demand for Alcoholic Beverages

NISSON, C. J.

- P-384 Conductive Plastics in Analog Computing

NOAH, J. W.

- RM-2786-PR Cost-Quantity Calculator

NOONAN, G. C., JR.

- RM-2177 The Simulated Aircraft and Its Failure Model in LP-I

NORTHROP, G. M.

- P-2536 On the Output Probability Density Function of a Linear Device with Certain Non-gaussian Random Inputs

NOVICK, D.

- R-254 Efficiency and Economy in Government through New Budgeting and Accounting Procedures
- ★ R-287 Weapon-system Cost Methodology
- RM-1759 A New Approach to the Military Budget
- RM-2695 System and Total Force Cost Analysis
- P-267 Use of the Learning Curve
- P-273 The What and the How Are Both Essential to Munitions Production
- P-530 Which Program Do We Mean in "Program Budgeting"?
- P-694 The Role of Management Tools in Making Military Decisions
- P-794 Weapon-system Cost Analysis
- P-1182 Concepts of Cost for Use in Studies of Effectiveness
- P-1197 Federal Spending for National Security
- P-1240 Lead-time in Modern Weapons
- P-1462 Economics of Defense Procurement and Small Business
- P-1779 What Do We Mean by "Research and Development"?
- P-1803 The Federal Budget as an Indicator of Government Intentions and the Implications of Intentions
- P-2135 Identifying R&D: A Management Problem
- P-2222 New Tools for Planners and Programmers
- P-2336 The Role of the Military Comptroller in Defense Management
- P-2568 Technological Change and Local Economy

OVERBECK, T. E.

- RM-12 A Note on the Lanchester Equations
- RM-13 A Second Note on the Lanchester Equations

★ Indicates publications which are out of print.

OBERBECK, T. E.—continued

- RM-15 The Location of the Maximum of a Function of Two Independent Variables When the Dependent and Independent Variables Are Measured without Error
RM-16 Maximizing $Z = Z(X, Y)$ When Z Is Known Exactly Only for Certain Values of One or Both Independent Variables

O'DELL, G. E.

- RM-2177 The Simulated Aircraft and Its Failure Model in LP-I

OKUN, B.

- RM-2233 Experimental Design, Test, and Evaluation of an F-100D Flyaway Kit
P-1225 Secular Trends in the Birth Ratio of Whites, by States, for the United States, 1870-1950
P-1458 A Rational Economic Model Approach to the Birth Rate
P-1725 Experimental Design, Test, and Evaluation of an F-100D Flyaway Kit

OLNEY, J.

- T-135 Electronic Computers in the Service of the National Economy

O'MARA, H. R.

- P-1021 Tracking and Communication for a Moon Rocket
P-1481 The Propagation of Errors in Keplerian Orbits

ORCHARD-HAYS, W.

- RM-1044 The Duplex System for IBM's Model II CPC: A Fast Four-address, Double-operation, Floating Decimal Setup
RM-1268 Notes on Linear Programming—Part V: Alternate Algorithm for the Revised Simplex Method Using a Product Form for the Inverse
RM-1268A Notes on Linear Programming—Part V: A Product-form Tableau for Revised Simplex Method, Computing Appendix for RM-1268
★ RM-1269 Notes on Linear Programming—Part VI: The RAND Code for the Simplex Method
RM-1275 Notes on Linear Programming—Part XII: A Composite Simplex Algorithm—II
RM-1433 Background, Development, and Extensions of the Revised Simplex Method
RM-1440 Notes on Linear Programming—Part VI: The RAND Code for the Simplex Method (SX4) (For the IBM 701 Electronic Computer)
P-374 Permanent Setups for IBM Calculators
P-416 The EIP: An External and Internal Program Setup for IBM's Model II CPC
P-440 The Product Form for the Inverse in the Simplex Method
P-482 Computational Experience in Solving Linear Programming Problems
P-562 Revisions and Extensions to the Simplex Method (With Side Lights on Programming Techniques)
P-688 Computing Experience with Linear Programming and Its Variants
P-810 Evolution of Computer Codes for Linear Programming
P-842 Manual for the RAND-IBM Code for Linear Programming on the 704
P-900 Evolution of Linear Programming Computing Techniques
P-908 Adaptability of the Linear Programming Codes
P-911 The Revised Simplex Method
P-916 The Complete Dualized System of the Simplex Method

ORDEN, A.

- RM-1264 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
RM-1265 Notes on Linear Programming—Part II: Duality Theorems
★ P-392 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints

OSBORN, H. A.

- RM-1368 On the Convergence of Discrete Stochastic Decision Processes to Their Continuous Analogues
RM-1414 On the Convergence of Discrete Stochastic Decision Processes to Their Continuous Analogues—II

★ Indicates publications which are out of print.

- P-718 The Problem of Continuous Programs
- P-731 A New Technique for Eigenvalue Problems—I
- P-1150 Dynamic Programming and the Variation of Green's Functions
- P-1164 The Existence of Conservation Laws—I
- P-1515 On the Foundations of Dynamic Programming
- P-1722 The Dirichlet Functional
- P-1728 The Existence of Conservation Laws—II

O'SULLIVAN, J. J.

- ★ R-341 Proceedings of the Second Protective Construction Symposium (Deep Underground Construction)—Vols. I and II
- RM-730 Time, Equipment, and Costs To Repair Cratered Runways
- RM-1151 Response of Drag Type Structure to Blast
- P-1431 Space-flight Ground-facility-requirements Problems: Launching Facilities
- P-2263 A Case for Survival Deep Underground
- T-28 Russian Tactics

OYSTER, D. E.

- S-118 Yields, CEP's, and Super-hardness

PARDEE, F. S.

- P-1589 Economic Considerations of Space Flight Ground Support Requirements
- P-1756 An Outsider Surveys the Place of Public-administration Research
- P-2006 Economic Planning and the Military Electronics Industry
- P-2021 Weapon System Cost Sensitivity Analysis as an Aid in Determining Economic Resource Impact
- P-2511 Scheduling State of the Art: Anathema or Necessity?

PARKIN, B. R.

- RM-1939 Fully Cavitating Hydrofoils in Nonsteady Motion
- RM-2173 A Review of Similitude Theory in Ground Shock Problems
- RM-2486 Impact Wave Propagation in Columns of Sand
- P-695 Calculation of Hydrofoil Sections from Prescribed Pressure Distributions
- P-1237 Experiments on Circular Arc and Flat Plate Hydrofoil in Noncavitating and Full Cavity Flows
- P-1745 Linearized Theory of Cavity Flow in Two Dimensions
- P-2004-1 Impact Wave Propagation in Columns of Sand
- P-2192 Impact Wave Propagation in Columns of Sand—Part II
- P-2350-1 Munk Integrals for Fully Cavitated Hydrofoils

PARKIN, T. R.

- P-2552 A One-day Look at Computing

PASCAL, A. H.

- P-1621-RC Proposal for a "Smog Tax"

PASSMAN, S.

- P-897 Atmospheric Transmission
- P-2047 Interactions of Infrared Radiation with the Atmosphere: A Guide to the Modern Literature
- P-2129 Infrared

PAUKER, G. J.

- RM-2619-RC Recent Communist Tactics in Indonesia
- RM-2637-RC The Role of the Military in Indonesia
- RM-2768 The Indonesian Eight-year Over-all Development Plan
- P-1452-RC Indonesian Images of Their National Self

★ Indicates publications which are out of print.

PAUKER, G. J.—continued

- P-1514-RC The Role of Political Organizations in Indonesia
- P-2229 General Nasution's Mission to Moscow
- P-2254 Current Communist Tactics in Indonesia
- P-2313 The Indonesian Eight-year Over-all Development Plan
- P-2347 Political Doctrines and Practical Politics in Southeast Asia
- P-2570 Sources of Turbulence in the New Nations

PAULSON, R. M.

- RM-2220 Implementing Logistics Policies in Laboratory Problem I (LP-I)
- RM-2365 Supply and Depot-repair Interactions: A Case Study of Electronics Support
- RM-2656 Base-depot Requisitioning Pipeline Times

PAULSON, R. S.

- RM-71 Tables of Dynamic Pressure

PAXSON, E. W.

- RM-74 A Differential Equation with Random Shocks

PEASE, J. S.

- ★ RM-1027 On the Interaction of Scalar and Electrostatic Fields

PEASE, R. L.

- ★ RM-1027 On the Interaction of Scalar and Electrostatic Fields

PEEBLES, G. H.

- R-240 Gamma-ray Transmission through Finite Slabs
- RM-1420-AEC Solutions of the Temperature-perturbed Thomas-Fermi Equation
- P-368 Attenuation of Gamma Rays—I: Transmission Values for Finite Slabs of Lead, Iron, and the Compton Scatterer
- P-368 Attenuation of Gamma Rays—II: Transmission Values for Various Materials and Geometries
- P-591-AEC Solutions of the Temperature-perturbed Thomas-Fermi Equation
- P-695 Calculation of Hydrofoil Sections from Prescribed Pressure Distributions

PEISAKOFF, M. P.

- RM-736 Continuous Blotto
- RM-884 More on Games of Survival

PENINGTON, M. B.

- T-124 Excerpts on the Ural-I and Ural-II Soviet Digital Computers

PENNINGTON, R. H.

- P-403 Effects of Surface Tension and Viscosity on Taylor Instability

PETERSEN, J. W.

- RM-1392 The Cost of Various Base Stocking and Requisitioning Policies for Aircraft Spare Parts
- RM-1402 A Summary of Some Base Supply Activity and Workload Reports
- RM-1867 Design Change Impacts on Airframe Parts Inventories
- RM-2085 Savings from Procurement Deferral with Interim Contractor Support: The Case of High-value Airframe Spares
- RM-2365 Supply and Depot-repair Interactions: A Case Study of Electronics Support
- P-611 The Costs of Alternative Air Base Stocking and Requisitioning Policies
- P-1055 Design Change Impacts of Airframe Parts Inventories
- P-1068 A Proposal for Reducing the Cost of Logistics Support

PETERSON, N. C.

- RM-245 Climb Path for Least Elapsed Time
- P-700 Remarks on the Design, Conduct, and Analysis of Large Air Exercises

★ Indicates publications which are out of print.

- P-889 Comments on Warfare in the Next Ten to Twenty Years
- P-1085 Remarks on Future Wars

PETERSON, R. P.

- RM-686 A Stochastic Development of "Ballantyne's Integral Equation"

PETRUSCHELL, R. L.

- P-1932 Sixty Years of Growth in Computing and Data-processing Capability

PHELPS, E. S., JR.

- P-1996 Optimal Inventory Policy for Serviceable and Repairable Stocks

PHINIZY, W. H.

- RM-316 Maneuvering and Scanning Barriers for All-Weather Interceptions: A Graphical Method

PHYSICS DEPARTMENT (Formerly known as the Physics Division)

- R-251-AEC (Amended) Worldwide Effects of Atomic Weapons: Project SUNSHINE

PICKREL, E. W.

- P-1981 Support Resources

PINKEL, B.

- RM-2280 A Correlation of the Critical Conditions for Homogeneous Bare Reactors
- P-1429 Propulsion Fundamentals
- P-1633 The Impact of the Space Age on Engineering Education
- P-1713 A Discussion of the Correlation of Critical Conditions for Bare Homogeneous Reactors

PLESSET, E. H.

- ★ RM-39 Bremsstrahlung Correction to Transmission of Gamma Rays through Thick Media

PLESSET, M. S.

- ★ R-132 Scattering and Absorption of Gamma Rays and Neutrons
- RM-32 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
- ★ RM-34 Determination of Shield Thickness for Attenuation of Air-scattered Gamma Radiation
- RM-1956 Note on the Sr⁹⁰ Hazard
- RM-2409 Note on the Strontium-90 Fallout
- ★ RAOP-40 Effects of Source and Shadow Shield Geometry on the Scattering of Gamma Rays
- P-157 Scattering and Absorption of Gamma Rays
- P-395 On the Stability of Fluid Flows with Spherical Symmetry
- P-1759 Transient Effects in the Distribution of Carbon-14 in Nature
- P-1782 Carbon-14 Production from Nuclear Explosions

POLLACK, S. L.

- RM-2013 Electronic Data-processing Control of Air Force Spare-parts Inventories
- RM-2177 The Simulated Aircraft and Its Failure Model in LP-I
- RM-2232 A Data-processing Concept for Air Force Bases
- RM-2681 The Role of Data Input in Automatic Data Processing Systems
- RM-3010-PR Data Description for DETAB-X (Decision Table, Experimental)
- P-2246 The Role of Data Input in Automatic Data Processing Systems
- P-2437 Development of a Business Language

PORCH, H. E.

- RM-2800-PR Economics Department Publications, 1948-1961: An Author Index of the Open Literature, with Abstracts

PORTS, D. C.

- P-1724 Military Radio Communications Equipment Trade-offs

POSTLEY, J. A.

- RM-1639-1 Research and Development of a New Data-processing System for Air Force Logistics

★ Indicates publications which are out of print.

POSTLEY, J. A.—continued

- RM-2232 A Data-processing Concept for Air Force Bases
- RM-2483 The Design of Complex Management Control Systems
- P-691 File Reference
- P-952 Large Data-handling Equipment as a Commercial Tool
- P-1230 Contrasts in Large File Memories for Large-scale Computers
- P-1617 Experiments in Single-point Data Processing in a Controlled Environment
- P-1783 Systems Design for Management Automation
- P-1961-RC Long-range Considerations in Data Processing for State and Local Governments

POWELL, R. P.

- RM-1872 A Materials-input Index of Soviet Construction, 1927/28 to 1955—Part I
- RM-1873 A Materials-input Index of Soviet Construction, 1927/28 to 1955—Part II:
Appendices
- RM-2454 A Materials-input Index of Soviet Construction, Revised and Extended

PRAGER, W.

- RM-2021 Notes on Linear Programming—Part XLII: Linear Programming and Structural Design
- RM-2887-PR Minimum-weight Design for Moving Loads
- P-1122 Linear Programming and Structural Design—I: Limit Analysis
- P-1123 Linear Programming and Structural Design—II: Limit Design

PRESS, F.

- RM-2456-AEC Probing the Earth with Nuclear Explosions
- P-2111-AEC Probing the Earth with Nuclear Explosions

PRESTRUD, M. C.

- P-2268 On a New Computational Solution of Time-dependent Transport Processes—I: One-dimensional Case
- P-2299-1 Hierarchic Algebra

PUSTULA, J. H.

- P-1978 Governors of the Conjunction Υ TO

PUTT, G. H.

- P-847 Administration of Research in a Research Corporation

PYE, L. W.

- P-2265 Armies in the Process of Political Modernization

QUADE, E. S.

- RM-168 Survival Chance with Correlation in Aim
- RM-213 The Duel with Time of Flight Not Zero
- RM-318 A Preliminary Model for an Air Battle
- P-1694 Pitfalls in Analysis

QUINE, W. V.

- RM-196 A Theorem on Parametric Boolean Functions
- RM-199 Commutative Boolean Functions
- RM-218 On Functions of Relations with Especial Reference to Social Welfare
- P-140 A Simplification of Games in Extensive Form

RADIO CORPORATION OF AMERICA

- RM-1158 Image Brightness Intensifiers

RADNER, R.

- RM-2536 The Use of Bayesian Techniques for Predicting Spare-parts Demand
- P-2074 Optimal Replacement and Inspection of Stochastically Failing Equipment

RAINEY, R. B., JR.

- RM-2374 The Base Maintenance-operations Model Used in RAND Logistics Research
- P-1548 A Simulation Model of Air Force Maintenance Operations
- P-1552 Random Variations and Sampling Models in Production Economics
- P-1826 A Structural Approach to Military Air Transportation

RAPP, R. R.

- RM-885 U.S. Flying Weather
- RM-1676-AEC A Catalog of Fallout Patterns
- RM-2006 Rate of Fall through the Atmosphere of Irregularly Shaped Particles
- RM-2460 Derivation of Two Simple Methods for the Computing of Radioactive Fallout
- P-733 Scientific Use of an Artificial Satellite
- P-822-AEC Close-in Fallout
- P-882-AEC A Mathematical Model of the Phenomenon of Radioactive Fallout
- P-1019 Dispersion in the Upper Atmosphere
- P-1830 Drag Coefficients of Small, Irregular Particles
- P-1879 The Accuracy of Winds Derived by the Radar Tracking of Chaff at High Altitudes
- P-1921 The Vertical Motion of Solid Spheres in the Atmosphere
- P-2262 Statistical Determination of Error in Parachute-derived Wind Velocities
- P-2354 Wind and Temperature in the Mesosphere

RAUNER, R. M.

- R-323 Laboratory Evaluation of Supply and Procurement Policies
- RM-2117 Simulated Wars in LP-I
- P-1334 The Logistics System Laboratory as a Research Tool
- P-2223-1 Simulation and Long-range Planning for Resource Allocation
- P-2355 Game-simulation and Long-range Planning

RAY, E. C.

- P-2496 Some Theorems concerning the Motion of an Electrically Charged Particle in a Dipole Magnetic Field

RAYMOND, A. E.

- P-2282 Reorientation of Engineers To Meet the Challenge of a Changing Technology: Industrial Aspects of the Problem

RAYMOND, J. L.

- RM-2292 Thermodynamic Properties of Carbon Dioxide to 24,000°K with Possible Application to the Atmosphere of Venus
- P-723 On the Stability of a Circular Cylinder at Hypersonic Speeds
- P-940 A Simple Relation between the Shock and Expansion Pressure Coefficients for Two-dimensional Hypersonic Flow
- P-1011 A Simple Relationship between the Shock and Expansion Pressure Coefficients as a Basis for Studying Two-dimensional Hypersonic Flow
- P-1189 Thin Airfoils in Hypersonic Flow with Strong Shocks
- P-1395 Piston Theory Applied to Strong Shocks and Unsteady Flow
- P-1976 The Far-field Back-scattering from a Concave Corner of a Body of Revolution
- P-2218-1 Thermodynamic Properties of Carbon Dioxide to 24,000°K
- T-74 On the Problem of a Streamlined Profile in a Near-sonic Flow

REDDING, A. D.,

- RM-703 Distribution of USSR Nonagricultural Employment, 1928-1950: A Preliminary Study
- RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan
- P-260 Reliability of Estimates of Unfree Labor in the USSR
- P-327 Employment and Labor Productivity in USSR Railroads, 1928-1950

REDMOND, P. J.

- P-1746 Some Consequences for Quantum Electrodynamics of an Essential Singularity at $\alpha = 0$
P-1767 The Consistency of Quantum Field Theories

REED, I. S.

- RM-2987-PR Approximate Band-pass Limiter Envelope Distributions
P-2106 Semi-coherent Detection
P-2116-1 Introduction to Sequential Circuits
P-2178 Note on the Existence of Perfect Maps
P-2186 The Compression of Finite Discrete Messages
P-2278-1 On a Moment Theorem for Complex Gaussian Processes
P-2301-1 Approximations of K th Order to Coherent Detection
P-2359 Overlapping Tessellated Communications Networks
P-2377-1 Path-invariant Comma-free Codes
P-2407 Probability and Statistics in Systems Work

REHKOP, A. J.

- RM-1923 Production Characteristics of Hi-Valu Airframe Spare Parts

REICH, D. L.

- P-2097 The Use of Protocols in Programming Research

REICH, E.

- RM-429 On Nicolson's Formula for Capacitance
RM-454 The Theory of Information
RM-748 Phase Coherence of Reflections from Scatterers
RM-1220 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements
RM-1321 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements: Minimum RMS Error in Computed Position
P-163 Capacitance of Circular Condenser
P-167 On the Definition of Information
P-201 The Game of "Gossip" Analyzed by the Theory of Information
P-305 On the Detection of a Sine Wave in Gaussian Noise
P-322 A Random Walk Related to the Capacitance of the Circular-plate Condenser
P-339 Transient Response of Butterworth Approximations of Ideal Low-pass Filters
P-786 On Schlicht Functions with Real Coefficients
P-846 Priority Assignment on a Waiting Line
P-863 Birth-Death Processes and Tandem Queues

REIGER, S. H.

- P-1677 Codes for the Correction of "Clustered" Errors
P-2396 Economic Aspects of Communication Satellite Systems

REINHARDT, G. C.

- P-983 Deterrence Is Not Enough
P-1326 *War—1974*: A Book Review

REINHART, E. E.

- RM-2445 Descriptive Guide to a Card Directory of U.S. Military Radio Communication Equipment
P-1724 Military Radio Communications Equipment Trade-offs

REITER, S.

- P-335 Activity Analysis of Technological Structures in Production: An Example

REMER, C. F.

- P-2208 The Trade Agreements of Communist China

RENNER, E. K.

- RM-2061 Studies in Machine Translation—5: Manual for Key punching Russian Scientific Text
RM-2065 Studies in Machine Translation—4: Manual for Pre-editing Russian Scientific Text

RENSHAW, J. R.

RM-1917-1 The Game Monopologs

RESCHER, N. H.

R-353 On the Epistemology of the Inexact Sciences

P-1513 On the Epistemology of the Inexact Sciences

RICCIARDI, F.

P-1056 On the Construction of a Multi-stage, Multi-person Business Game

RICHARDSON, J. M. (HUGHES AIRCRAFT COMPANY)

RM-2354 On the Application of Dynamic Programming to a Class of Implicit Variational Problems

P-1374 On the Application of Dynamic Programming to a Class of Implicit Variational Problems

P-1898 On the Stability of Solutions of the Linearized Plasma Equation

P-1930 Perturbation and Renormalization—I

P-2190 A Note on an Inverse Problem in Mathematical Physics

P-2309 Renormalization Techniques and Mean Square Averaging—I: Deterministic Equations

P-2335 Self-consistent Solutions of Deterministic and Stochastic Nonlinear Differential Equations

P-2393 On the Asymptotic Behavior of Solutions of Nonlinear Differential Equations

RICHARDSON, J. R.

RM-255 Experimental Program

ROBACKER, J. T.

RM-1498 On Network Theory

RM-1521 Some Experiments on the Traveling-salesman Problem

RM-1548 The Number of Distinct Cuts in a Network

RM-1660 Min-Max Theorems on Shortest Chains and Disjunct Cuts of a Network

RM-1739 Some Observations on the Maximization of Stieltjes Integrals

RM-1799 Notes on Linear Programming—Part XXXVII: Concerning Multicommodity Networks

ROBBINS, J. J.

RM-1407 Recent Military Thought in Sweden on Western Defense

T-65 A Tank Duel with Game-theoretic Implications

ROBINSON, J. B.

RM-303 On the Hamiltonian Game (A Traveling-salesman Problem)

RM-406 Routing of Empties for Fixed-schedule Transportation

RM-407 A Note on the Hitchcock-Koopmans Problem

P-154 An Iteration Method of Solving a Game

ROCKMORE, R. M.

P-2431 Spin Susceptibility of Normal Fermion Systems

RODDEN, W. P.

P-625 A Simplified Expression for the Dihedral Effect of a Flexible Wing

P-626 On Use of the General Bending Formula

P-654 An Aeroelastic Parameter for Estimation of the Effects of Flexibility on the Lateral Stability and Control of Aircraft

RODIN, N. W.

RM-924 A Tentative Input-Output Table for the USSR, 1941 Plan

RM-1116 Productivity in Soviet Iron Mining, 1890-1960

ROOT, L. E.

★ RA-15005 The Interim Study

★ RA-15068 Propellers for High-speed Long-range Airplanes

★ Indicates publications which are out of print.

ROSENTHAL, A. H.

RM-2656 Base-depot Requisitioning Pipeline Times

ROSETT, R. N.

P-1444 A Table for Obtaining Trial Values for Estimating Relationships in Which the Dependent Variable Is Limited

ROSIN, R. F.

P-1771 Translation of Artificial Languages by Compiler Programs

ROWAN, M. B. (BUREAU OF APPLIED SOCIAL RESEARCH, COLUMBIA UNIVERSITY)

RM-1723 The Views of Corporation Executives on the Probable Effect of the Loss of Company Headquarters in Wartime

ROWE, A. J.

RM-1512 An Analysis of Machine Tool Substitution Possibilities

RM-1549 A Compendium of Pressworking Operations

ROWELL, L. N.

RM-2671 A Method for Determining Approximate Propulsion Cutoff Conditions for Ballistic Interplanetary Trajectories

RM-2881-PR Some Methods for Establishing Interplanetary Transfer Orbits

P-1611 Secular Variation in the Inclination of the Orbit of Earth Satellite (1957 β) and Air Drag

P-2002 Effect of Geometrical Libration on the Damped Motion of an Earth Satellite

P-2285 A Method for Determining Approximate Initial Conditions for Interplanetary Trajectories

T-85-PR The Determination of Orbits

ROWEN, H. S.

P-1640 Defense Planning and Organization

P-1660 Is Defense Spending Wasteful?

RUGGLES, M. J.

RM-1674 Collective Leadership and the Political Police in the Soviet Union

RM-1711 The Soviet Union and the Atom: The Early Years

RM-1819 Soviet Collective Leadership

P-418 The Soviet Image of the U.S.

P-853 Soviet Atomic Policy

RUMER, W. I.

P-2153 Standards, Standardization, and Test Equipment

T-102 On the Probability of an n -Coincidence

T-105 The Interception Problems of Intercontinental Missiles

RUSH, M.

RM-1883 Khrushchev and the Stalin Succession: A Study of Political Communication in the USSR

RM-1947 Khrushchev and the Political Crisis of June, 1957

RM-2763 The Khrushchev Succession Problem

P-1135 Khrushchev and the Political Crisis of June, 1957

P-1146 Khrushchev as Senior Secretary: His Rise and His Ambitions

P-1312 The Bureaucratic Elite in Soviet Politics

P-1373 Talmudism in Soviet Politics

P-1469 Military Thought and Politics in the USSR

P-1641 The Communist World of Mr. Lippman

P-1965 Deterrence of Unlimited War: A Propositional Outline

P-2283 The Khrushchev Succession Problem

P-2386-1 The Succession Problem and the Transition to Communism

RYSER, H. J.

RM-2896-PR Widths and Heights of $(0, 1)$ -Matrices

- RM-2897-PR Multiplicities and Minimal Widths for $(0, 1)$ -Matrices
- RM-2898-PR Width Sequences for Special Classes of $(0, 1)$ -Matrices
- P-1792 Widths and Heights of $(0, 1)$ -Matrices
- P-1922 Traces, Term Ranks, Widths and Heights
- P-2272 Multiplicities and Minimal Widths for $(0, 1)$ -Matrices

SACKMAN, J.

- P-2066 Surface Waves in an Elastic Half-space
- P-2212 Load Moving with Super-seismic Speed over a Layered Elastic Solid

SAFONOV, G.

- ★ R-233 Notes on Multigroup Techniques for the Investigation of Neutron Diffusion
- R-259 Survey of Reacting Mixtures Employing U^{235} , Pu^{239} , and U^{233} for Fuel and H_2O , D_2O , C, Be, and BeO for Moderator
- R-279 Critical Mixtures of Uranium and 500°F Light Water
- R-316 Externally Moderated Reactors
- RM-842 A Study of Homogeneous H_2O , D_2O , U^{235} Reactors with a Note on Optimum Moderating Mixtures for a Minimum U^{235} Requirement
- RM-1520 The Criticality and Some Potentialities of "Cavity Reactors"
- RM-1814 Note on Neutron Flux-current Boundary Conditions at Gaps in One-dimensional Systems
- RM-1835 (Abr.) The Criticality and Some Potentialities of "Cavity Reactors"
- RM-1870 Direct Conversion of Fission to Electric Energy in Low-temperature Reactors
- P-838 Lecture Notes on the Effects of Neutron Irradiation on Reactor Fuel Composition and Reactivity
- P-931 Resonance Escape Probability in Natural Uranium and H_2O - D_2O Mixtures
- P-986 Engineering Test Reactors with Large Central Irradiation Cavities

SALLAGAR, F. M.

- P-848-RC The Search for Decision in National Defense

SALTER, R. M.

- P-249 The Current and Predicted Status of Engineering Techniques in Relation to Human Travel at Upper Altitudes

SALVADORI, M. G.

- RM-1806 Report on the Dynamic Strength of Rigid-plastic Beams under Blast Loads

SAMS, C. F., M.D.

- RM-2519 A Mathematical Model of the Human External Respiratory System
- P-1811 A Mathematical Model of the Human External Respiratory System
- P-2048 A Mathematical Model of the Chemistry of the External Respiratory System

SAMUELSON, P. A.

- RM-114 Note on Optimal Decisions in Differential Equation Processes
- ★ RM-179 Market Mechanisms and Maximization—III: Dynamics and Linear Programming
- ★ RM-210 The Le Chatelier Principle in Linear Programming
- ★ RM-484 Equilibrium Points in Game Theory
- ★ RM-540 Notes on the Dynamic Approach to Saddle-points and Extremum Points: Gradient Methods and the Equations of Classical Mechanics
- ★ P-69 Market Mechanisms and Maximization
- P-292 Abstract: Proofs of the Law of Diminishing Returns
- ★ P-461 Interrelations between Linear Programming and Game Theory
- P-685 Linear Programming and Economic Theory

SANDOVAL, C. A.

- RM-1401 The Strength of Anchor Bolts Set in Concrete

★ Indicates publications which are out of print.

SANDOVAL, C. A.—continued

- RM-1677 Vulnerability of Fuel Storage Tanks to Nuclear Blast: Response and Scaling of Floating Roof Tanks
RM-2277 A Handbook for Estimating Material Requirements and Costs of Shelter Doors Subjected to Long-duration Blast Loading

SARTOR, J. D.

- RM-2006 Rate of Fall through the Atmosphere of Irregularly Shaped Particles
RM-2080 A Method for Evaluating Environmental Effects on Military Operations
RM-2322 Evaluation of the Effect of Environment on Refueling Operations
RM-3049-PR Essential Factors of Thunderstorm Forecasting
P-912 A Systematic Approach to Local Objective Forecast Studies
P-1299 Meteorological Aspects of Infrared Operations
P-1824 The Mutual Attraction of Cloud Droplets in the Electrostatic Field of the Atmosphere
P-1829 Dynamic Similarity and the Modeling of Cloud Droplets
P-1830 Drag Coefficients of Small, Irregular Particles
P-1895 The Evaluation of the Effect of the Environment on a Complex Operation
P-1920 A Comparison of Hydrodynamic and Electrostatic Forces on Cloud Droplets
P-1960 Some Electrostatic Cloud-droplet Collision Efficiencies
P-2121 Calculations of Cloud Electrification Based on a General Charge Separation Mechanism
P-2134 The Role of the Electrostatic Field in the Coagulation of Fog and Cloud Droplets
P-2345 Recalculations of Cloud Electrification Based on a General Charge-separation Mechanism

SAVAGE, L. J.

- RM-184 An Apparent Ambiguity in the Interpretation of Minimum Risk
RM-597 Games with Circular Symmetry
P-1132 The Casino That Takes a Percentage and What You Can Do about It

SCARF, H. E.

- RM-1320 Games with Information Lag
RM-1480 The Convergence of the Discrete Analogues of Differential Games—Part I
RM-1504 The Maximization of an Integral Subject to Constraints
P-742 On Differential Games with Survival Payoffs
P-797 Games with Partial Information
P-910 A Min-Max Solution of an Inventory Problem
P-1193 A Concept of Stability in Manpower Planning

SCHAIRER, R. S.

- ★ RA-15068 Propellers for High-speed Long-range Airplanes

SCHAMBERG, R.

- ★ R-114 Effects of Flight Speed and Propulsive System on Aircraft Range
★ R-130 An Approximate Method for the Calculation of Airplane Radius Factor
RM-233 Application of Concepts from Kinetic Theory of Gases to Interception Problem
RM-1201 A Simplified Physical Interpretation of Whitcomb's "Area Rule" for the Reduction of Supersonic Pressure Drag
RM-2313 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow with Application to Neutral-particle Drag Estimates of Satellites
RM-2327 Military Supersonic Transports
P-1017 Generalized Analysis of Aerial Campaigns against Strategic Targets
P-1609 A New Analytic Representation of Surface Interaction for Hyperthermal Free-molecule Flow, with Application to Satellite Drag
P-1865 On the Future of Operations Research in the Aircraft and Space Systems Industries
P-2266 Free Molecule Flows
T-69 The Attainability of the Stars (*Die Erreichbarkeit der Fixsterne*)

SCHECHTER, H. B.

- P-1636 Some Weight Considerations for Manned Lunar Missions

★ Indicates publications which are out of print.

- P-1659 An Improved Solution for the Motion of Bodies in Free Fall
- P-2157 Determination of Interplanetary Transfer Orbits for Specified Date of Departure
- T-115 The Stellar Ecospheres within a Radius of 17 Light-years around the Sun

SCHELLING, T. C.

- RM-2510 Nuclear Weapons and Limited War
- RM-2515 The Role of Theory in the Study of Conflict
- P-1342 The Reciprocal Fear of Surprise Attack
- P-1385 Re-interpretation of the Solution Concept for "Non-cooperative" Games
- P-1386 For the Abandonment of Symmetry in the Theory of Cooperative Games
- P-1491 Prospectus for a Reorientation of Game Theory
- P-1574 Surprise Attack and Disarmament
- P-1620 Nuclear Weapons and Limited War
- P-1648 Toward a Theory of Strategy for International Conflict
- P-1716 Randomization of Threats and Promises

SCHEUER, E. M.

- P-2144 On the Generation of Normal Random Vectors

SCHILLING, G. F.

- P-2387 On the Consequences of a Possible Ozonosphere on Mars

SCHNITZER, E. W.

- RM-967 Bundestag Debates on Allied-German Relations: Allied-German Relations as Reflected in Selected Debates of the Bundestag, January to April, 1952
- RM-981 Public Discussion in Western Germany of the Defense of Europe, March to June, 1952
- RM-1056 Some Developments in German Aviation
- RM-1119 Soviet Policy on the Reunification of Germany, 1945-1952
- RM-1210 German Geopolitics Revived: A Survey of Geopolitical Writing in Germany Today
- RM-1372 Some German Press Views on the Defense of Europe: A Survey of West German Press Opinion on Military Aspects of the Defense of Europe
- RM-1373 A Summary of *Recent Thought in Sweden on Western Defense* by James J. Robbins
- RM-2557 West European Comments on Soviet Posture as Presented in Khrushchev's Speech of January 14, 1960
- P-501 German Geopolitics Revived
- P-1106 A German Discussion of Atomic Weapons and the Law
- T-29 When Can the Soviet Union Risk Atomic War?
- T-33 The Secret Weapons of the Soviet Union
- T-40 Soviet Long-range Bomber Bases near the North Pole
- T-43 Two German News Items on Atomic Developments in the Soviet Union
- T-103 East Bloc Forgeries: A Weapon in the Cold War
- T-104 The Development of Chinese Communist Military Forces
- T-108 Political Control in the East German People's Army
- T-114 German Reports on East Bloc Activities: Central Planning for Atomic Protection in the East Bloc; and Ideological Training in the East German People's Army
- T-121 Summit Skirmishes in the Cold War
- T-122 "Military Disengagement in Central Europe": A Speech by *Bundestag* Delegate Helmut Schmidt (SPD)
- T-123 West European Opinion on Defense—No. 41: German Polls of 1959 on Rearmament, Atomic Energy, Nuclear Weapons, the Balance of World Power, and Prospects of Peace
- T-136 West German Attitudes toward Economic Aid for Underdeveloped Areas

SCHWARTZ, J. I.

- P-692 FACT Loop Expansion

SCITOVSKY, T.

- ★ RM-175 The Pricing System in Peacetime

SCOTT, B. J.

- RM-2068 Studies in Machine Translation—8: Manual for Postediting Russian Text

★ Indicates publications which are out of print.

SCOTT, B. J.—continued

- P-1624 Studies in Machine Translation—8: Manual for Postediting Russian Text
- P-1720 A Russian Structure for Comparison
- T-124 Excerpts on the Ural-I and Ural-II Soviet Digital Computers
- T-134 Electronic Digital Machines and Programming

SCOTT, D. H.

- P-2520 The Inhuman Style

SEARS, P. M.

- P-2501 Recovery of the Bendegó Meteorite

SEKERA, Z.

- R-389-PR Distribution of the Intensity and Polarization of the Diffusely Reflected Light over a Planetary Disk
- RM-2502 Extension of the "WKB" Approximation of High-frequency Scattering by a Dielectric Sphere—Part I: General Expressions

SELIN, I.

- RM-3090-PR Interpolation and Extrapolation of Stationary Random Sequences
- RM-3091-PR On the Structure of Stationary Random Functions
- P-2055 A Series Expansion for $\log I_0(z)$
- P-2067 Synchronization of Coherent Detectors
- P-2487 The Design of a Sequential Test for the Detection of Known Signal in Normal Nonwhite Noise
- P-2498 Some Simple Examples of Singular Detection of Continuous Signals in Noise
- T-92 Theory and Applications of the Notion of Complex Signal
- T-129 On the Spectral Theory of Stochastic Processes
- T-131 On Linear Methods in Probability Theory

SELZNICK, P.

- ★ R-201 The Organizational Weapon: A Study of Bolshevik Strategy and Tactics
- P-136 Institutional Vulnerability in Mass Society

SEPMAYER, L. W.

- RM-958-1 A Field Trial of an Air Force Electronic Equipment Reliability Study Program
- RM-1002 The Cost of Unreliability of Air Force Airborne Electronic Equipment as Represented by the Cost of Maintenance
- RM-1257 Electronic Reliability and Supply Improvement Based on Failure Reporting and Presentation
- P-545 Methodology for Reliable Failure Reporting from Maintenance Personnel
- P-573 Techniques in Putting Failure Data to Work for Management

SERBIN, H.

- RM-1713 Hypersonic, Nonviscous Flow around a Circular Disk Normal to the Stream
- RM-1772 Hypersonic, Nonviscous Flow around a Sphere
- RM-1967 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface
- P-930 Hypersonic, Nonviscous Flow around a Circular Disk Normal to the Stream
- P-1069 Supersonic Flow around Blunt Bodies
- P-1172 The High-speed Flow of Gas around Blunt Bodies
- P-1210 The Intense Stress Field Produced in the Elastic Earth by a Bomb Blast at the Surface

SEWELL, W. P.

- P-818 Maintenance of a Group of Machines Utilized Intermittently and Subject to Several Types of Malfunctions—I: Operational Requirements and Resource Allocations

SHABAD, T.

- RM-815-1 Population of Major Cities of the USSR
- P-269 The Soviet Concept of Economic Regionalization

★ Indicates publications which are out of print.

SHANLEY, F. R.

- ★ R-222 Weight-Strength Analysis of Aircraft Structures
- ★ RM-391 Derivation of a Wing Weight Formula for a Thin Wing Structure
- RM-598 Preliminary Investigation of a Prestressed Ceramic Wing
- ★ RM-605 Weight Analysis of Thick-plate Wing Structures
- RM-1127 Fatigue Analysis of Aircraft Structures
- RM-1198 Proposal for Reduction of Factors of Safety for Military Airplanes
- RM-1439 A Comparison of the FFA and RAND Methods of Fatigue Analysis
- RM-1476 A Proposed Mechanism of Fatigue Failure
- RM-2011 On the Strength of Fine Wires
- RM-2180 Plastic Behavior of Thin Plates under Normal Pressure
- RAOP-33 Principles of Structural Design for Minimum Weight
- P-68 Analysis of Stress-Strain-Time Relations from the Engineering Viewpoint
- P-82 Simplified Analysis of General Instability of Stiffened Shells in Pure Bending
- P-202 Principles of Creep Buckling
- P-350 A Theory of Fatigue Based on Unbonding during Reversed Slip
- P-641 Creep Buckling: An Engineering Survey
- P-666 A Proposed Mechanism of Fatigue Failure
- P-920 On the Mechanism of Fatigue
- P-1654 On the Strength of Fine Wires
- P-1749 Discussion of Methods of Fatigue Analysis
- P-1765 Laminated Metal-ceramic Composite Materials
- P-2259 On the Ultimate Tensile Strength and Elongation of Ductile Materials
- P-2331 Historical Note on the 1.5 Factor of Safety for Aircraft Structures

SHAPIRO, H. N.

- RM-677 The Determination of Decision Regions for a Simplified Two-plane Bombing Model
- RM-880 On the Everywhere Denseness of a Certain Semigroup of Transformations
- RM-933 Decision Processes and Functional Equations
- RM-949 Some Simple Nonlinear Models
- P-382 Studies in Functional Equations Occurring in Decision Processes

SHAPIRO, M. B.

- RM-2415 The Flight Operations Planner
- RM-2525 Addendum to RM-2415, *The Flight Operations Planner*
- P-2056 Solving the Chemical Equilibrium Problem Using the Decomposition Principle

SHAPIRO, N. Z.

- RM-2415 The Flight Operations Planner
- RM-2648 Values of Large Games—I: A Limit Theorem
- P-744 Degrees of Computability

SHAPLEY, L. S.

- RM-33 Two Theorems Concerning Solutions for Games with Continua of Strategies
- RM-101 A Hidden-target Model
- RM-118 Note on Duels with Continuous Firing
- RM-128 A Game-solving Technique
- RM-137 A Three-move Game with Imperfect Communication
- RM-201 Graphical Solution of 3×3 Matrices
- RM-204 Note on the Solution of Convex Games
- RM-205 A Tactical Reconnaissance Model
- RM-208 Reconnaissance in Game Theory
- RM-268 Games with Many Moves
- RM-444 A Remark on the Silent Duel with Positive Initial Accuracy, and on Associated Silent and Noisy Duels
- RM-445 The Silent Duel, One Bullet versus Two, Equal Accuracy
- RM-638 On Determining the Full Set of Solutions of a Finite Game
- RM-641 The Noisy Duel: Existence of a Value in the Singular Case

★ Indicates publications which are out of print.

SHAPLEY, L. S.—continued

- RM-656 Notes on the n -Person Game—I: Characteristic-point Solutions of the Four-person Game
- RM-670 Notes on the n -Person Game—II: The Value of an n -Person Game
- RM-817 Notes on the n -Person Game—III: Some Variants of the von Neumann-Morgenstern Definition of Solution
- RM-881 Notes on the n -Person Game—IV: A Theorem on C -Stable Sets
- RM-898 An Example of an Infinite, Nonconstant-sum Game
- RM-1005 n -Person Games—V: Stable-set Solutions, Including an Arbitrary Closed Component
- RM-1142 Order Matrices—I
- RM-1145 Order Matrices—II
- RM-1320 Games with Information Lag
- RM-1384 Simple Games: An Outline of the Descriptive Theory
- RM-1533 A Symmetric Market Game
- RM-1598 A Condition for the Existence of Saddle-points
- RM-1818 Equilibrium Points in Games with Vector Payoffs
- RM-2240 Complements and Substitutes in the Optimal Assignment Problem
- RM-2338 On Network Flow Functions: Notes on Linear Programming and Extensions—
- Part 50
- RM-2476 Symmetric Games
- RM-2533 Notes on n -Person Games—VI: On Solutions That Exclude One or More Players
- RM-2648 Values of Large Games—I: A Limit Theorem
- RM-2649 Values of Large Games—II: Oceanic Games
- RM-2650-PR Values of Large Games—III: A Corporation with Two Large Stockholders
- RM-2651 Values of Large Games—IV: Evaluating the Electoral College by Montecarlo Techniques
- RM-2860-PR Values of Large Games—V: An 18-Person Market Game
- RM-2912-PR Values of Games with Infinitely Many Players
- RM-3026-PR On the Nonconvergence of Fictitious Play
- P-57 Solutions of Discrete, Two-person Games
- P-66 Games with Continuous, Convex Payoff
- P-74 Some Applications of a Theorem on Convex Functions
- P-97 Geometry of Reduced Moment Spaces
- P-100 Polynomial Games
- P-227 Geometry of Moment Spaces
- P-295 A Value for n -Person Games
- P-297 Quota Solutions of n -Person Games
- P-622 On Games of Survival
- P-629 Markets as Cooperative Games
- P-797 Games with Partial Information
- P-888 A Solution Containing an Arbitrary Closed Component
- P-1212 Equilibrium Points in Games with Vector Payoffs
- P-1392 The Solutions of a Symmetric Market Game
- P-2131 New Directions in the Application of Game Theory: An Abstract
- P-2184 Complements and Substitutes in the Optimal Assignment Problem
- P-2185 On Network Flow Functions
- P-2240 College Admissions and the Stability of Marriage
- P-2277 Simple Games: An Outline of the Descriptive Theory
- P-2371 Minimal k -Arc-connected Graphs

SHARKEY, E. H.

- RM-2300-RC The Rocket Performance Computer
- P-1629 The Advantages of Functional Packaging of Electronic Equipment
- P-1764 Survival Position Location Using Star Sighting

SHARPE, W. F.

- RM-2566 Aircraft Compartment Design Criteria for the Army Deployment Mission
- P-1621-RC Proposal for a "Smog Tax"
- P-2082 Aircraft Compartment Design Criteria for the Army Deployment Mission

SHAW, J. C.

- P-416 The EIP: An External and Internal Program Setup for IBM's Model II CPC
- P-951 Empirical Explorations of the Logic Theory Machine: A Case Study in Heuristics
- P-954 Programming the Logic Theory Machine
- P-971 Elements of a Theory of Human Problem Solving
- P-987 Problem Solving in Humans and Computers
- P-1277 A Command Structure for Complex Information Processing
- P-1319 Chess-playing Programs and the Problem of Complexity
- P-1320 The Processes of Creative Thinking
- P-1584 Report on a General Problem-solving Program
- P-1742 A Variety of Intelligent Learning in a General Problem Solver

SHELTON, W. V.

- P-2050 An Example of Man-Machine Simulation in Logistics Research
- P-2264-1 Some Suggested Techniques for Data System Development

SHEPARD, R. W.

- R-210 A Study of Project SCOOP Linear Programming
- R-318 A Time Series Analysis of Interindustry Demands
- RM-674 Note on the Problem of Aggregation
- P-251 An Econometric Model of Interindustry Material Flows
- P-309 A Survey of Input-Output Research
- T-19 Elementary Theory of Convex Polyhedrons

SHERMAN, S.

- RM-202 Total Reconnaissance with Total Countermeasures: Simplified Model
- RM-208 Reconnaissance in Game Theory
- P-106 Total Reconnaissance with Total Countermeasures: Simplified Model

SHIELDS, W. H.

- RM-1978 Resolution of Real-coefficient Polynomials in Control System Analysis

SHIFFMAN, M.

- RM-193 A Bomber-Fighter Duel—II
- RM-243 On the Equality $\text{Min Max} = \text{Max Min}$, and the Theory of Games
- P-131 On Games of Timing

- ★ P-232 On the Min Max of $\int_0^1 f(x)a(x)d(x) dt(x)$

SHUBIK, M.

- P-222 A Comparison of Treatments of a Duopoly Situation

SHULMAN, M. D.

- P-2344 Prelude to Policy: Understanding

SIBLEY, W. L.

- R-368 Geomagnetic Field Lines in Space
- P-1541 Lines of Force of the Geomagnetic Field in Space
- P-1726 Remarks on Auroral Isochasms
- P-1795 The Geomagnetic Field in Space, Ring Currents, and Auroral Isochasms

SIEGERT, A. J. F.

- RM-447 On the Roots of Markoffian Random Functions
- RM-689 Empirical Determination of Noise Spectra
- RM-1643 On the Problem of Determining the Position of a Target with Constant Signal in the Presence of Circuit Noise or Chaff
- RM-1973 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- P-236 On the Evaluation of Noise Samples
- P-238 The First Passage Problem for a Continuous Markoff Process
- P-419 Passage of Stationary Processes through Linear and Nonlinear Devices

★ Indicates publications which are out of print.

SIEGERT, A. J. F.—continued

- P-429 On the Distribution of Certain Functionals of Markoff Processes
- P-730 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena—II: Examples
- P-738 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena
- P-939 A Systematic Approach to a Class of Problems in the Theory of Noise and Other Random Phenomena—III: Examples

SIMON, C. W.

- ★ RM-1222 Considerations for Research in a Sleep-learning Program
- RM-1442 Responses to Material Presented during Various Levels of Sleep
- RM-1444 The Nonrecall of Material Presented during Sleep
- P-534 A Critical Review of the "Learn-While-You-Sleep" Studies
- P-565 Considerations for Research in a Sleep-learning Program
- P-618 Responses to Material Presented during Various Levels of Sleep
- P-619 The Nonrecall of Material Presented during Sleep
- P-655 The EEG, Consciousness, and Sleep

SIMON, H. A.

- RM-922 Observations and Comments on the Organization Studies of the Systems Research Laboratory
- RM-2506 The Simulation of Human Thought
- P-204 A Formal Theory of the Employment Relationship
- P-219 A Comparison of Organization Theories
- P-234 On the Application of Servomechanism Theory in the Study of Production Control: A Study in the Theory of Organization
- P-365 A Behavioral Model of Rational Choice
- P-850 Current Developments in Complex Information Processing
- P-868 The Logic Theory Machine: A Complex Information Processing System
- P-951 Empirical Explorations of the Logic Theory Machine: A Case Study in Heuristics
- P-971 Elements of a Theory of Human Problem Solving
- P-987 Problem Solving in Humans and Computers
- P-1277 A Command Structure for Complex Information Processing
- P-1319 Chess-playing Programs and the Problem of Complexity
- P-1320 The Processes of Creative Thinking
- P-1584 Report on a General Problem-solving Program
- P-1708 What Have Computers To Do with Management?
- P-1734 The Simulation of Human Thought
- P-1742 A Variety of Intelligent Learning in a General Problem Solver
- P-2221 Modeling Human Mental Processes
- P-2257 GPS: A Program That Simulates Human Thought
- P-2276 Computer Simulation of Human Thinking
- P-2311 Forgetting in an Association Memory
- P-2312 Computer Simulation of Human Thinking and Problem Solving
- P-2349 Experiments with a Heuristic Compiler
- P-2358 Performance of a Reading Task by an Elementary Perceiving and Memorizing Program
- P-2375 A Theory of the Serial Position Effect

SISKA, C. P.

- RM-1338 Analytic Formulation of a Theater Air-Ground Warfare System (1953 Techniques)
- P-198 Supersonic Flow around Cones at Large Yaw

SKAVDAHL, H.

- P-690 A System for Cataloguing Reference Material

SKOGSTAD, A. L.

- RM-428 Petroleum Industry of Germany during the War

★ Indicates publications which are out of print.

- RM-563 Estimating Output from Floor Space: Feasibility
 P-93 The Prediction of Social and Technological Events

SMITH, B. L.

- R-285 International Communication and Political Opinion: A Guide to the Literature

SMITH, C. H.

- RM-2655 Studies in Machine Translation—12: A Glossary of Russian Physics

SMITH, C. M.

- R-285 International Communication and Political Opinion: A Guide to the Literature

- ★ RM-974 International Communication and Political Warfare: An Annotated Bibliography

SMITH, F. T.

- RM-2581 A Discussion of a Midcourse Guidance Technique for Space Vehicles
 RM-2716 Equations of Perturbed Motion for a Satellite in a Nearly Circular, Nearly Equatorial Orbit
 P-1568 A Discussion of Space Vehicle Guidance Problems
 P-1665 A Discussion of Several Concepts Used in the Optimization of Control Systems by Dynamic Programming
 P-2177-1 The Optimization of Multi-stage Orbit Transfer Processes by Dynamic Programming
 P-2343-1 Equations of Perturbed Motion for Low-eccentricity Orbits
 T-85-PR The Determination of Orbits
 T-118 The Approximate Calculation of an Ephemeris in Unperturbed Elliptic Motion
 T-119 Concerning the Approximate Calculation of an Ephemeris in the Restricted Problem of Three Bodies
 T-125 The Solution of Linear Differential Equations by the Method of the Complete Differential

SMITH, G. K.

- RM-2461 A Parametric Study of the Performance of Air-launched Ballistic Missiles

SMITH, M. C.

- RM-2323 A Generalized Formulation for Inertial Navigators and Gravitationally Stabilized Satellites
 P-1520 On the Drag of a Sphere Moving in a Partially Ionized Atmosphere
 P-1611 Secular Variation in the Inclination of the Orbit of Earth Satellite (1957 β) and Air Drag
 P-2002 Effect of Geometrical Libration on the Damped Motion of an Earth Satellite

SMITH, R. W.

- RM-2157 The Big Squeeze, or the Utility of the Heavy Presses
 RM-2786-PR Cost-Quantity Calculator

SMITH, V. L.

- P-1424 An Econometric Study of Aircraft Malfunction Behavior

SNOW, R. N.

- ★ RA-15078 Contributions to Lanchester Attrition Theory
 RM-951 The Problem of Defining and Measuring Railroad Capacity
 RM-2765-PR Some Characteristics of the Elliptic Gaussian Distribution

SOCIAL SCIENCE DEPARTMENT (Formerly known as the Social Science Division)

- RM-207a Soviet Military Intelligence: Comments on the Book *Handbook for Spies* by Alex Foote
 RM-1403-8 A Selected List of Unclassified Publications of the Social Science Department. The RAND Corporation, 1948-1961

★ Indicates publications which are out of print.

SPECHT, R. D.

- RM-350 The Rayleigh-Ritz Method in Compressible Flow Problems
- ★ RM-1072 The Rate of Advance of the Front Line in Some World War II Campaigns
- P-579 Gaming as a Technique of Analysis
- P-1041 War Games
- P-1601 RAND, A Personal View of Its History

SPEIER, H.

- R-298 German Rearmament and Atomic War
- RM-1837 Soviet Atomic Blackmail and the North Atlantic Alliance
- P-119 The American Soldier and the Sociology of Military Organization
- P-196 Psychological Warfare Reconsidered
- P-270 International Political Communication: Elite versus Mass
- P-458 German Rearmament and the Old Military Elite
- P-471 War and Peace
- P-615 Psychological Aspects of Foreign Policy
- P-1094 Soviet Atomic Blackmail and the North Atlantic Alliance
- P-1400 Disengagement
- P-1679-RC Some Observations on Political Gaming

SPRINGER, J. Y.

- P-1462 Economics of Defense Procurement and Small Business

SQUIRES, W. K.

- RM-2057-2 A Preliminary Examination of Single-sideband Communications
- RM-2169 An Identification System for Use as an Aid to Raid Detection and Air Traffic Control
- RM-2225 Two Methods of Obtaining Earth Satellite Positions from Simple Photographic Observations
- P-1684 A Note on the Computation of Single-sideband Peak Power

STAFF

- RM-28 Active Defense of the United States against Air Attack

STAHL, R.

- T-146 Digital Computers in the Soviet Union

STEARNS, E. V.

- RM-323 On the Expected Damage from Single Bomb Drops

STEEL, T. B., JR.

- P-857-AD PACT-1A

STEGER, W. A.

- RM-1830 Air Force Provisioning Policies: An Analysis
- RM-1867 Design Change Impacts on Airframe Parts Inventories
- RM-2182 Costs of Procurement Deferral with Interim Contractor Support: Hi-Valu Airframe Spares
- RM-2365 Supply and Depot-repair Interactions: A Case Study of Electronics Support
- RM-3066-PR Determining Preferred Management Techniques in New Systems through Game-simulation
- P-1055 Design Change Impacts on Airframe Parts Inventories
- P-1068 A Proposal for Reducing the Cost of Logistics Support
- P-1219 The Use of Gaming and Simulation Devices in Business
- P-1789 Economic Consequences of Substantial Changes in the Method of Taxing Capital Gains and Losses
- P-2223-1 Simulation and Long-range Planning for Resource Allocation
- P-2234 The Use of Manned Simulation in the Weapon System Planning Process
- P-2296 Simulation and Tax Analysis: A Research Proposal
- P-2322 The Use of Manned Simulation in the Design of an Operational Control System

★ Indicates publications which are out of print.

- P-2355 Game-simulation and Long-range Planning
P-2521 Quality Control and Reliability for Total Weapon System
P-2574 Problems of Support Planning
- STERN, E. A.**
P-2070 The Effect of Interactions on Determination of Fermi Surfaces
P-2270 Boundary Effects on the Energy Loss of Charged Particles
- STEVENS, D. F.**
P-1755 On the Rationalization of Certain Complex Elliptic Integrals
- STEWART, R. M.**
P-2178 Note on the Existence of Perfect Maps
- STEWART, W. A.**
P-2206 Some Linguistic Problems of Russian Graphic Abbreviations
- STOLLER, D. S.**
RM-2131 Management Information for the Maintenance and Operation of the Strategic Missile Force
RM-2508 The Measurement of Missile Reliability in Pre-launch Operating Environments
P-556 Univariate Two-population Distribution-free Discrimination
P-646 The Application of Statistical Methods to the Design and Analysis of Experiments
P-819 Some Queueing Problems in Machine Maintenance
P-929 A Failure Model for Equipments Undergoing Complex Operation
P-1362 Design of a Management Information System
P-1672 Measuring the Reliability of Equipments in Operating Environments
P-1685 The Aggregation of Servicing Facilities in Queueing Processes
P-1810 Measuring Missile Reliability in Pre-launch Environments
P-2053 The Effect of Maintenance and Reliability on the Operational Effectiveness of an Interceptor Squadron
P-2144 On the Generation of Normal Random Vectors
P-2362 On the Determination of Occupational Categories in an Organization
T-71 On Some Identically Distributed Statistics
- STONE, J. J.**
P-1478 A Mathematical Study of Arbitrage
P-1490 The Cross-section Method: An Algorithm for Linear Programming
- STOUT, D. E.**
P-993-RC Japan's Economic Future in Asia
- STRAHLE, W. C.**
P-2436 The Computation of Oblique Shock Wave Characteristics for Real Gases
P-2456 The Thermodynamic Properties of 85% CO₂ and 15% Nitrogen to 24000°K
- STURDEVANT, C. V., III**
★ RA-15016 An Analysis of the Guided Missile-Strategic Bomber Interception Problem: App. II to Fourth Quarterly Reports, RA-15033 and RA-15034
RM-310 Performance Effects of Refueling
RM-612 Radius Extension Effects of Refueling a Bomber by Dissimilar Tankers
RM-713 Ratio of Crew to Aircraft Requirements as Affected by Attrition
RM-797 Desirability of In-the-Air Overloading of Aircraft
RM-1632 Expected Damage from Single and Multiple Bombs to Targets Distributed Uniformly around a Circle
RM-1654 The Influence of an Aggressor's Attack Effectiveness upon the Characteristics Desired for a Defender's Air Force
- SUMMERFIELD, J. R.**
P-1517 The Peacetime Use of Military Airlift
P-1882 A Model for Evaluating Fleets of Transport Aircraft
P-2076 Compatibility of Military and Commercial Airlift Requirements

★ Indicates publications which are out of print.

SUTTON, R. I.

- RM-2061 Studies in Machine Translation—5: Manual for Key punching Russian Scientific Text
- RM-2064 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats
- P-1352 Studies in Machine Translation—3: Résumé of Machine Codes and Card Formats

SWEETLAND, A. F. M.

- P-1988 An Analysis of the Decisionmaking Functions of a Simulated Air-defense Direction Center
- P-2457 Beginner's FORTRAN

SWERLING, P.

- RM-989-1 Some Factors Affecting the Performance of a Tracking Radar
- RM-1008 The "Double-threshold" Method of Detection
- RM-1217 Probability of Detection for Fluctuating Targets
- RM-1220 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements
- RM-1238 Detection Range of an Active Radar Seeker
- RM-1321 Statistical Theory of Navigation Employing Independent Inertial and Velocity Measurements: Minimum RMS Error in Computed Position
- RM-1491 Maximum Angular Accuracy of a Pulsed Search Radar
- RM-1564 Automatic Navigation Aided by Intermittent Position Fixes
- RM-1719 Performance of the "Double-threshold" Radar Receiver in the Presence of Interference
- RM-2172 A Possible Transponding System for an Artificial Asteroid
- RM-2273 A Problem in Spectrum Estimation
- RM-2329 First-order Error Propagation in a Stagewise Smoothing Procedure for Satellite Observations
- P-305 On the Detection of a Sine Wave in Gaussian Noise
- P-722 Families of Transformations in the Function Spaces H^p
- P-745 Maximum Angular Accuracy of a Pulsed Search Radar
- P-1185 A Method of Computing the Inherent Accuracy with Which a Time Delay Can Be Estimated
- P-1206 Optimum Linear Estimation for Random Processes as the Limit of Estimates Based on Sampled Data
- P-1221 Approximate Evaluation of an Expression Arising in the Theory of Time-delay Estimation
- P-1247 Note on the Minimum Variance of Unbiased Estimates of Doppler Shift
- P-1292 A Proposed Stagewise Differential Correction Procedure for Satellite Tracking and Prediction
- P-1393 Some Information-theory Considerations in Space Communications
- P-1442 Some Aspects of Astronautics
- P-1443 Space Communications
- P-1468 Parameter Estimation for Waveforms in Additive Gaussian Noise
- P-1674 First-order Error Propagation in a Stagewise Smoothing Procedure for Satellite Observations
- P-1788 Estimation of Doppler Shifts in Noise Spectra
- P-1862 The Resolvability of Point Sources
- P-1968 A Computer Program for First-order-error Propagation in Satellite-orbit Prediction
- P-2080 Paradoxes Related to the Rate of Transmission of Information
- P-2301-1 Approximations of K th Order to Coherent Detection
- P-2423 Sequential Detection in Radars with Multiple Resolution Elements

TAMARKIN, P.

- P-2019 A Note on the Cause of Sudden Ionization Anomalies in Regions Remote from High-altitude Nuclear Bursts

P-2249 VLF Ionospheric Reflection Coefficients: Derivation from Impedance Concepts and Values for Some Model Ionospheres

P-2409 An Extension to VLF Reflection Coefficients

TAMPLIN, A. R.

RM-2542 The Sabatier Reaction for Inorganic Recovery of Oxygen in Manned Space Capsules

TANHAM, G. K.

P-2214 Laos: The Current Phase in a Cyclic Regional Revolution

TARSKI, A.

R-109 A Decision Method for Elementary Algebra and Geometry

TATUM, F. A.

RM-2491 A Parametric Study of Surface-to-air Missiles versus Low-altitude Targets

TAYLOR, W. W.

P-546-RC Cold Water on Salt Water

T-76 *The Causes of Systematic Error in the Cost Estimates of Public Works* by R. Giguet and G. Morlat (Paris, 1952)

TELLER, E.

P-1594 A Seismic Scaling Law for Underground Explosions

THOMAS, J. R.

P-1859 Report on Service with the American Exhibition in Moscow

T-98 Translations of Two Soviet Articles on Law and Order in Outer Space

T-107 Soviet Book Review of A. S. Whiting's *Soviet Policies in China, 1917-1924*

T-110 World-wide Historic Victory of the Soviet People

T-112 "Why the USA Is Straining To Get into Outer Space"

THOMAS, T. Y.

RM-3031-PR On a Mechanical Interpretation of the Null Geodesics in Static Einstein-Riemann Spaces

RM-3039-PR On the Characterization of Contemporaneous and Born Rigid Motions and the Question of Their Equivalence

P-2369 Discontinuities in the Einstein-field for General Momentum-energy Tensors

P-2411 Differential Compatibility Conditions on the Momentum-energy Tensor and Necessary Conditions for the Existence of Solutions to the Einstein Field Equations

THOMPSON, F. B.

RM-747 Two Examples Concerning Behavior Strategies

RM-759 Equivalence of Games in Extensive Form

RM-769 Behavior Strategies in Finite Games

P-306 New Currents in an Old Stream

THOMPSON, J. S.

P-181 Lunar Parallax Method of Astronavigation

P-746 A New Approach to Penetration Mechanics

THOMSON, W. T.

RM-1159 Behavior of Metals at High Rates of Loading

RM-1160 An Approximate Theory of Armor Penetration

THRALL, R. M.

RM-693 Some Remarks on the Double Description Method

RM-724 A Generalization of Numerical Utilities

RM-909 Some Results in Nonlinear Programming

RM-935 Some Results in Nonlinear Programming—Part II

TIEMAN, E.

★ RA-15021 Flight Mechanics of a Satellite Rocket

★ Indicates publications which are out of print.

TONGE, F. M.

- P-1799 Summary of a Heuristic Line Balancing Procedure
- P-1929 An Introduction to Information Processing Language—V
- P-1993 A Heuristic Program for Assembly-line Balancing
- P-2127 The Use of Heuristic Programming in Management Science

TRINKL, F. H.

- RM-2474 A Stochastic Force Survival Model

TUCKER, R. C.

- ★ RM-1223 The Metamorphosis of the Stalin Myth
- RM-1441 Stalin and the Uses of Psychology
- RM-1636 Forces for Change in Soviet Society
- RM-1874 The Politics of Soviet De-Stalinization
- RM-1881 The Psychological Factor in Soviet Foreign Policy
- RM-1949 The Changing Pattern of Soviet Foreign Policy
- P-507 The Metamorphosis of the Stalin Myth
- P-815 Stalin and the Uses of Psychology
- P-945 The Russian Future: Is a New Optimism Justified?
- P-1052 The Psychological Factor in Soviet Foreign Policy
- P-1058 The Politics of Soviet De-Stalinization
- P-1142 Forces for Change in Soviet Society
- P-1265 The Image of Dual Russia
- P-1341 A Preface to U.S. Policy toward Russia
- P-1570 Impressions of Russia in 1958: A Trip Report

TUKEY, J. W.

- RM-1317 Notes on the Analysis of "Immersed" Variance

TUPAC, J. D.

- RM-1754 A Revised Data-processing System for Managing War Reserve Stocks of Aircraft Spare Parts
- RM-2572 The LP-II Data-processing System
- P-2115 Experience in the Use of a Simulation Laboratory in the Design of a Management Information System

TURGEON, E. L.

- RM-767 Prices of Ordinary Rolled Steel in the Soviet Union, 1928–1950
- RM-778 Prices of Quality Rolled Steel in the Soviet Union, 1928–1950
- RM-802 Prices of Iron and Steel Products in the Soviet Union, 1928–1950: A Summary Report
- RM-1030 Prices of Nonferrous Metals in the Soviet Union, 1928 to 1950
- RM-1112 Prices of Metalworking Equipment in the Soviet Union, 1928–1951
- RM-1244 Prices of Industrial Electric Power in the Soviet Union, 1928 to 1950
- RM-1423 Prices of Coal and Peat in the Soviet Union, 1928–1950
- RM-1482 Prices of Miscellaneous Basic Industrial Products, USSR, 1928–1950
- RM-1522 Basic Industrial Prices in the USSR, 1928–1950: Twenty-five Branch Series and Their Aggregation
- RM-1919 Prices of Basic Industrial Goods in the USSR, 1950 to 1956: A Preliminary Report
- P-789 Prices of Basic Industrial Products in the USSR, 1928–1950

TWANMO, C.

- RM-1659 Production of Food Crops in Mainland China: Prewar and Postwar

ULLMAN, R. J.

- RM-2425 Computing Tetraethyl-lead Requirements in the Linear-programming Format: Notes on Linear Programming and Extensions—Part 52
- P-1545 Computing Tetraethyl Lead Requirements in the Linear Programming Format

★ Indicates publications which are out of print.

UNIVERSITY OF MICHIGAN

★ P-321 University of Michigan-RAND Summer Session Papers

VAN DYKE, M. D.

- RM-702 The Axial Pressure Force on an Inclined Body of Revolution in Supersonic Flow
P-125 First- and Second-order Theory of Supersonic Flow Past Bodies of Revolution

VAN HORN, R. L., JR.

- RM-2131 Management Information for the Maintenance and Operation of the Strategic Missile Force
P-1362 Design of a Management Information System
P-2447 Systematic Methods for Programming Simplification

VAN VALKENBURG, M. E.

- P-746 A New Approach to Penetration Mechanics

VASUDEVAN, R.

- P-2361 A Note on Perturbation Series

VEINOTT, A. F., JR.

- RM-3021-PR Optimal Capacity Scheduling

VERNON, R. E.

- T-52 The Motion of a Satellite Station around the Earth in an Elliptical Orbit Inclined to the Earth's Equator
T-54 Possibilities of Transition from an Elliptical Orbit to a Circular Orbit, and Vice Versa

VESTINE, E. H.

- R-368 Geomagnetic Field Lines in Space
RM-1933 Utilization of a Moon-rocket System for Measurement of the Lunar Magnetic Field
RM-2106 Evolution and Nature of the Lunar Atmosphere
P-1040 Seasonal Changes in Day-to-Day Variability of Upper Air Winds near the 100-km Level of the Atmosphere
P-1121 Ionospheric Electric-current Systems Derived Using International Polar Year Data
P-1296 Citizenship: The Viewpoint of Science and Technology
P-1335 Space-vehicle Environment
P-1344 Physics of Solar-terrestrial Space: Lunar Flight
P-1426 Some Remarks on the Nature and Origin of Noctilucent Cloud Particles
P-1442 Some Aspects of Astronautics
P-1541 Lines of Force of the Geomagnetic Field in Space
P-1626 Some Preliminary Scientific Findings of the International Geophysical Year
P-1631 Magnetic Storms
P-1710 Note on Conjugate Points of Geomagnetic Field Lines for Some Selected Auroral and Whistler Stations of the IGY
P-1726 Remarks on Auroral Isochasms
P-1753 Geomagnetic Control of Auroral Phenomena
P-1795 The Geomagnetic Field in Space, Ring Currents, and Auroral Isochasms
P-1816 Polar Auroral, Geomagnetic, and Ionospheric Disturbances
P-1845 The Upper Atmosphere and Geomagnetism
P-1860 Maximum Total Energy of the Van Allen Radiation Belt
P-1863 The Survey of the Geomagnetic Field in Space
P-1940 Polar Magnetic, Auroral, and Ionospheric Phenomena
P-1957 Note on the Direction of High Auroral Arcs
P-1977 Geomagnetic Control of the Van Allen Radiation Belts
P-2007 Some Consequences of Local Acceleration of Auroral Primaries
P-2035 Geomagnetism in Relation to Aeronomy
P-2101 Theory of Auroral Morphology
P-2406 World Magnetic Survey: Introductory Remarks

★ Indicates publications which are out of print.

VIEZEE, W.

- R-389-PR Distribution of the Intensity and Polarization of the Diffusely Reflected Light over a Planetary Disk
RM-2492 Survey of Radiometric Quantities and Units
P-1972 A Preliminary Computation of Pressure and Temperature between 100 and 800 Kilometers
P-2079 Mie Scattering with Complex Index of Refraction

VOGELY, W. A.

- RM-1934-RC A Case Study in the Measurement of Government Output

VON NEUMANN, J.

- P-142 Solutions of Games by Differential Equations
P-2169 Symmetric Solutions of Some General n -Person Games

VOOSEN, B. J.

- R-358 Automatic Checkout Equipment: Employment and Design Considerations
RM-2455 Misslogs: A Game of Missile Logistics
RM-2485 Missile Prelaunch Confidence Checkout: Content and Equipment Design Criteria
RM-2750 An Omnibus of Briefing Papers on Analysis of Automatic Checkout Equipment and Aids to Its Design
P-1997 Optimizing a Prelaunch Checkout

WAGNER, H. M.

- RM-2702 An Examination of the Use of Statistical Aggregates To Improve Management Control of Large Organizations
RM-3021-PR Optimal Capacity Scheduling
P-417 Matrix Inversion on an Automatic Calculator by Row and Column Partitioning
P-609 A Linear-programming Solution to Dynamic Leontief Type Models
P-1160 Statistical Decision Theory as a Guide to Information Processing
P-1191 Dynamic Problems in the Theory of the Firm
P-1314 The Foundations and Advances in Game Theory
P-1465 A New Look at Experience Rating
P-1478 A Mathematical Study of Arbitrage

WAGNER, R. A.

- RM-408 A Continuous Colonel Blotto Game
RM-414 Solution of a Game with Constraints
RM-693 Some Remarks on the Double Description Method
RM-747 Two Examples Concerning Behavior Strategies
P-245 An Analysis of Three-move Finite Games

WAINSTEIN, E. S.

- RM-1294 A Comparison of Soviet and United States Retail Food Prices for 1950
RM-1606 A Comparison of Soviet and United States Retail Prices for Manufactured Goods and Services in 1950
RM-1692-1 A Comparison of Soviet and American Retail Prices in 1950
RM-1906 An Addendum to Previous USSR-U.S. Retail Price Comparisons
RM-2495 Indexes of Soviet Industrial Output
P-901 A Comparison of Soviet and American Retail Prices in 1950

WALSH, J. E.

- RM-148 Some Comments on an Estimation Problem for Contaminated Populations
RM-177 On the Usefulness of Artificial Dispersion for a Certain Bombing Problem
RM-224 A Mathematical Model of an Air Transportation System
RM-406 Routing of Empties for Fixed-schedule Transportation
RAOP-7 On the Power Function of a Sign Test Formed by Using Subsamples
RAOP-8 On the "Information" Lost by Using a t -Test When the Population Variance Is Known
RAOP-10 Concerning Compound Randomization in the Binary System

- RAOP-13 Some Bounded Significance Level Properties of the Equal-tail Sign Test
- ★ RAOP-32 On the Best Choice of Sample Sizes for a t -Test When the Ratio of Variances Is Known
- RAOP-42 Some Bounded Significance Level Tests of Whether the Largest Observations of a Set Are Too Small
- P-61 Some Nonparametric Tests of Whether the Largest Observations of a Set Are Too Large or Too Small
- P-65 Some Estimates and Tests Based on r Smallest Values in a Sample
- P-80 On the Power Function of the "Best" t -Test Solution of the Behrens-Fisher Problem
- P-86 Large Sample Tests and Confidence Intervals for Mortality Rates
- P-91 On the Power Function of Tests of Percentage Points Based on the Noncentral t -Statistics
- P-92 Some Comments on the Efficiency of Significance Tests
- P-102 On a Generalization of the Behrens-Fisher Problem
- P-112 Concerning the Effect of Small Correlation on Certain Large Sample Tests and Confidence Intervals for the Mean
- P-129 A Large Sample t -Statistic Which Is Insensitive to Nonrandomness
- P-133 Some Tests for Comparing Percentage Points of Two Arbitrary Continuous Populations
- P-156 Some Bounded Significance Level Tests for the Median
- P-180 Some Nonparametric Results for Experimental Designs
- WALTERS, P. A.**
- RM-1676-AEC A Catalog of Fallout Patterns
- WALTERS, S. S.**
- RM-366 On the Min Max of a Bilinear Form
- RM-446 On the Number of Eigenvalues of a Certain Symmetric Kernel
- RM-450 On Functions of the Form $\sum_{i=1}^n \varphi_i(x)\psi_i(y)$
- WARD, J. W.**
- P-1834 Manned Control of Orbital Rendezvous
- WARE, W. H.**
- RM-2541 Soviet Computer Technology: 1959
- P-377 The History and Development of the Electronic Computer Project at the Institute for Advanced Study
- P-434 Computers Unlimited: Digital Machines in Tomorrow's Business World
- P-608 The Digital Computer: Where Does It Go from Here?
- P-1008 Reliability and the Computer
- T-124 Excerpts on the Ural-I and Ural-II Soviet Digital Computers
- T-133 A Specialized Digital Computer and an Experiment in Its Use (A Computer with Reduced Capabilities)
- T-134 Electronic Digital Machines and Programming
- T-146 Digital Computers in the Soviet Union
- WARSHAW, M.**
- P-1807 Tables of the Binomial Probability Distribution $b(r; N, p)$ for Large N and Small p
- WATERS, G.**
- RM-1268A Notes on Linear Programming—Part V: A Product-form Tableau for Revised Simplex Method (Computing Appendix for RM-1268)
- WATSON, K. M.**
- P-2399 Detection of Nuclear Explosions
- WATSON, K. R.**
- P-1126 Scattering of Light by Protons
- WAX, N.**
- P-1812 On a Phase Method for Treating Sturm–Liouville Equations and Problems
- ★ Indicates publications which are out of print.

WEBER, C. M., JR.

- T-106 On an Atomic Airplane
- T-120 Calculation of the Flight Characteristics of a Supersonic Airplane with Turbojet Engines
- T-139 Calculation of Required Thrust Taking into Account Compressibility

WECHSLER, J. W.

- ★ RM-391 Derivation of a Wing Weight Formula for a Thin Wing Structure

WEGNER, L. H., JR.

- RM-2491 A Parametric Study of Surface-to-air Missiles versus Low-altitude Targets

WEHNER, R. S.

- RM-262 Limitations of Focused Aperture Antennas

WEIDLINGER, P.

- RM-1806 Report on the Dynamic Strength of Rigid-plastic Beams under Blast Loads
- RM-2715 Structures under Repeated Blast Loadings
- P-2058 A Contribution to the Dynamic Elastic-plastic Analysis of Structures

WEIFENBACH, A.

- RM-2418 The Base Repair Cycle for the F-102 Fire Control System

WEINER, M. G.

- RM-2413 War Gaming Methodology
- P-529 Observations on the Growth of Information-processing Centers
- P-660 Systems Behavior—II: The Developmental Process
- P-753 *Cogwheel*: A Film Story of Systems Research Laboratory's Activities
- P-1105 The History, Purpose, and Script of *Cogwheel*
- P-1773 An Introduction to War Games
- P-2123 Gaming Limited War
- P-2466 The Use of War Games in Command and Control Analysis

WENDEL, J. G.

- RM-698 An Embedding of a Utility Space in an Ordered Vector Space
- RM-721 Short Proof of a Theorem of Gross
- RM-858 Remark on a Theorem of Danskin
- RM-894 A Characterization of the Normal Distribution
- P-271 Ordered Vector Spaces

WHITE, W. B.

- ★ R-149 The Composition and Thermodynamic Properties of Air at Temperatures from 500 to 8000°K and Pressures from 0.00001 to 100 Atmospheres
- RM-417 Calculation of Specific Impulse and Other Rocket Performance Characteristics
- RM-432 An Approximate Method for the Determination of Maximum Ramjet Impulse
- RM-436 Tables of Contributions to Thermodynamic Properties due to Gas Imperfection
- RM-660 Tables in Brief: Mathematical Tables for Use with Desk Calculators
- RAOP-2 A Simplified Method for Computing the Equilibrium Composition of Gaseous Systems
- RAOP-31 A Note on the Numerical Problem of Matrix Inversion
- P-835 Physical Properties of the Atmosphere from 90 to 300 Kilometers
- P-1059 Chemical Equilibrium in Complex Mixtures
- P-1060 A Linear-programming Approach to the Chemical Equilibrium Problem
- P-1286 Chemical Thermodynamics in Rocket Nozzles

WHITE, W. L.

- RM-1443 A Comparison of 1950 Wholesale Prices in Soviet and American Industry

WHITIN, T. M.

- P-1191 Dynamic Problems in the Theory of the Firm
- P-2421 Various Properties of the Poisson Distribution

★ Indicates publications which are out of print.

WHITING, A. S.

- R-356 China Crosses the Yalu: The Decision To Enter the Korean War
- RM-1992 "Contradictions" in the Moscow-Peking Axis
- P-1183 "Contradictions" in the Moscow-Peking Axis
- P-1447 Dynamics of the Moscow-Peking Axis
- P-1714 The Sino-Soviet Alliance: How Durable?
- P-1953 Sinkiang and Sino-Soviet Relations
- P-2029 Conflict Resolution in the Sino-Soviet Alliance

WIDDER, D. V.

- RM-187 Mechanical Inversion of the Laplace Transform
- RM-190 A Problem in Fourier Transforms Connected with the Design of an Antenna
- P-639 Variational Problems with Constraints

WILLENZ, E.

- RM-515 German Press Reaction to the Air War in Korea
- RM-968 Early Discussions regarding a Defense Contribution in Germany (1948-1950)

WILLIAMS, E. P.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
- P-87 Lift on Inclined Bodies of Revolution in Hypersonic Flow
- P-940 A Simple Relation between the Shock and Expansion Pressure Coefficients for Two-dimensional Hypersonic Flow
- P-1256 Aerodynamics for Space Flight

WILLIAMS, I. K.

- RM-335 A Study of the Factors Affecting the Choice of Frequency for an Airborne Microwave Relay System
- P-121 Theory of Blind Navigation by Dynamical Measurements

WILLIAMS, J. D.

- ★ RA-15008 Effect on Military Worth of Exchanging Bombing Accuracy for Bomber Safety by Increasing Range of Bomb
- RM-2285-RC Some Attributes of the Changing Society
- P-354 Conflicts with Imprecise Payoffs
- P-1556 Comments on Automobile Traffic
- P-1579-RC Some Attributes of the Changing Society
- P-1772-RC The Small World
- P-2170 Toward Intelligent Machines
- P-2383 Anyone for the Moon?

WILLMARTH, W. W.

- RM-2078 The Production of Aerodynamic Forces by Heat Addition on External Surfaces of Aircraft
- P-813 The Optimum Distribution of Lift in Certain Prismatic Regions at Supersonic Speed

WILSON, A. G.

- P-1406 Experiments in Interplanetary Biomigration and Space Contamination
- P-1425 Prologue to a Syntax of Space Exploration
- P-1427 The Space Environment
- P-1432 Interplanetary Exploration
- P-1442 Some Aspects of Astronautics
- P-1509 Spectrographic Observations of the Blue Haze in the Atmosphere of Mars
- P-1593 The Problem of the Martian Blue Haze
- P-1757 Probing Space: The Astronomer's View
- P-1801 A Scientist's Notes on the Cold War
- P-2068 Observations of the Blue Haze in the Atmosphere of Mars

WILSON, J. A.

- RM-286 Pursuit Path Method: Maneuvering Bomber
- RM-400 Two-airplane Formation Design: Generalized Theory

★ Indicates publications which are out of print.

WINESTONE, R. L.

RM-2200 Cost and Performance Data from LP-I: The First Experiment in Simulation by the Logistics Systems Laboratory

WING, G. M.

- RM-2318 A Note on the Numerical Integration of Nonlinear Partial Differential Equations
P-960 Hydrodynamical Stability and Poincaré-Lyapunov Theory—I
P-996 On the Principle of Invariant Imbedding and One-dimensional Neutron Multiplication
P-1067 A Note on the Numerical Integration of a Class of Nonlinear Hyperbolic Differential Equations
P-1102 On the Principle of Invariant Imbedding and Neutron Transport Theory—I: One-dimensional Case
P-1252 Invariant Imbedding and Neutron Transport Theory—II: Functional Equations
P-1380 Invariant Imbedding and Neutron Transport Theory: A Generalized Approach
P-1390 Invariant Imbedding and Generalized Transport Theory: A Basic Stochastic Functional Equation
P-1408 Invariant Imbedding and Neutron Transport Theory—III: Neutron-Neutron Collision Processes
P-1495 Invariant Imbedding and Neutron Transport Theory—IV: Generalized Transport Theory
P-1700 Invariant Imbedding and Neutron Transport in a Rod of Changing Length
P-1835 Invariant Imbedding and Neutron Transport Theory—V: Diffusion as a Limiting Case
P-1858 Invariant Imbedding and Mathematical Physics—I: Particle Processes
P-1952 Dissipation Functions and Invariant Imbedding—I
P-2014 Invariant Imbedding, Conservation Relations, and Nonlinear Equations with Two-point Boundary Values
P-2071 Invariant Imbedding and the Reduction of Two-point Boundary Value Problems to Initial Value Problems
P-2122 Invariant Imbedding and Variational Principles in Transport Theory

WINOGRAD, B.

- ★ RM-974 International Communication and Political Warfare: An Annotated Bibliography

WINSTEN, C. B.

- RM-1488 Studies in the Economics of Transportation
P-448 The Allocation of Switching Work in a System of Classification Yards

WINTER, S. G., JR.

- RM-2844-PR Postattack Damage Assessment: A Conceptual Analysis
P-2167 Economic Natural Selection and the Theory of the Firm
P-2384 A Boundedness Property of the Closed Linear Model of Production
P-2416 Economic Recovery from the Effects of Thermonuclear War

WOHLSTETTER, A. J.

- P-1472 The Delicate Balance of Terror
P-1530 Systems Analysis versus Systems Design
P-1877 On the Value of Overseas Bases
P-2084-RC No Highway to High Purpose

WOLF, C., JR.

- RM-1778-RC Economic Development and Mutual Security: Some Problems of U.S. Foreign Assistance Programs in Southeast Asia
RM-2952-PR Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
P-972-RC Soviet Economic Aid in Southeast Asia: Threat or Windfall?
P-1061-RC Comments Prepared for Annual Meeting of the Association for Asian Studies, Panel Discussion of Economic Development in South Asia, Sheraton-Plaza, Boston, April 3, 1957
P-1136 Factor Productivity and Economic Growth
P-1340-RC Economic Research on Southeast Asia in the United States: Status and Needs

★ Indicates publications which are out of print.

- P-1583 Gains from Trade, Materials Supplies, and Economic Development
- P-1743 Competition and Complementarity between Defense and Development: A Preliminary Approach
- P-2217 Economic Aid Reconsidered
- P-2274-1 Economic Development and Postwar Recuperation: A Comparison of Industrial Priorities
- P-2288 On Aspects of Korea's Five-year Development Plan
- P-2291-1 Defense and Development in Less Developed Countries

WOLFE, P. S.

- R-351 The RAND Symposium on Mathematical Programming: Linear Programming and Recent Extensions—Proceedings of a Conference, March 16–20, 1959
- RM-1264 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
- RM-2388 The Simplex Method for Quadratic Programming: Notes on Linear Programming and Extensions—Part 51
- RM-2813-PR The Decomposition Algorithm for Linear Programming: Notes on Linear Programming and Extensions—Part 57
- RM-2956-PR An Algorithm for Scaling Matrices: Notes on Linear Programming and Extensions—Part 58
- RM-2957-PR Linear Programming in a Markov Chain: Notes on Linear Programming and Extensions—Part 59
- ★ P-392 Notes on Linear Programming—Part I: The Generalized Simplex Method for Minimizing a Linear Form under Linear Inequality Restraints
- P-1205 The Simplex Method for Quadratic Programming
- P-1544 A Decomposition Principle for Linear Programs
- P-1667 The Secant Method for Simultaneous Nonlinear Equations
- P-1842 Linear Programming in a Markov Chain
- P-2010 Accelerating the Cutting Plane Method for Nonlinear Programming
- P-2028 A Duality Theorem for Nonlinear Programming
- P-2063 Recent Developments in Nonlinear Programming—Part I
- P-2181 The Present Status of Nonlinear Programming
- P-2333-1 Recent Developments in Nonlinear Programming—Part II
- P-2363 An Algorithm for Scaling Matrices
- P-2373 An Extended Composite Algorithm for Linear Programming
- P-2446 Some Simplex-like Nonlinear Programming Procedures

WONG, J. P., JR.

- ★ R-264 Approximations for Digital Computers
- RM-1251 The D.P.F.D.: A Double Precision (18 Digits) Floating Decimal Setup for IBM's Model II CPC
- P-348 Analytical Approximations, Volume IV
- P-355 Analytical Approximations, Volume V
- P-358 Analytical Approximations, Volume VI
- P-364 Analytical Approximations, Volume VII
- P-376 Analytical Approximations, Volume VIII
- P-387 Analytical Approximations, Volume IX
- P-397 Analytical Approximations, Volume X
- P-404 The Incomplete Approximator (In Six Fits)
- P-415 Analytical Approximations, Volume XI
- P-426 Analytical Approximations, Volume XII
- P-441 Analytical Approximations, Volume XIII
- P-515 Analytical Approximations, Volume XIV
- P-555 Analytical Approximations, Volume XV
- P-559 Analytical Approximations, Volume XVI
- P-592 Analytical Approximations, Volume XVII
- P-595 Analytical Approximations, Volume XVIII
- P-601 Analytical Approximations, Volume XIX
- P-607 Analytical Approximations, Volume XX

★ Indicates publications which are out of print.

WOODWORTH, L. R.

- RM-106 Gas Turbine Cycle Analysis by Means of Entropy Changes and Polytropic Component Efficiencies
RM-763 A Simple Method for Calculating the Thrust of Turbojet Engines with Underexpanded, Convergent Exhaust Nozzles
RM-838 Tabulated Results of Hot Gas Generator Cycle Calculations
RM-1039 Performance Analysis Methods for the Twin-spool, High-pressure Ratio, Turbojet Engine
RM-1205 Approximate Methods for Determining the Performance of Gas Turbine Engines at Off-design Conditions
RM-1571 The Significance of Major Cycle Variables on Turbojet Engine Performance at Mach 3.0
P-210 The Generalized Approach to the Selection of Propulsion Systems for Aircraft

WRIGHT, K. R.

- RM-3010-PR Data Description for DETAB-X (Decision Table, Experimental)

WYLLIE, J.

- RM-279 Notes on $(m \times 2)$ Evaluation Matrices for Special Systems Analysis Applications
RM-312 Bomber Formations Analysis: Simplified Air Battle Attrition Theory
RM-400 Two-airplane Formation Design: Generalized Theory

WYLLY, A.

- ★ R-141 A Two-dimensional Airfoil in Unsteady Supersonic Flow

YEH, K. C.

- RM-1821 Electric Power Development in Mainland China: Prewar and Postwar

YOUNG, D. M.

- P-465 On the Crank-Nicolson Procedure for Parabolic Partial Differential Equations
P-1709 SPADE, A Set of Subroutines for Solving Elliptic and Parabolic Partial Differential Equations

YOUNG, G. B. W.

- R-181 Long-range Surface-to-surface Rocket and Ramjet Missiles: Aerodynamics
RM-48 An Elucidation of Stone's Solution for a Slightly Yawing Supersonic Cone
RM-770 A Hypersonic Approximation of the Pressure Forces on Ogives
RM-1615 Basic Supersonic Ramjet Point-design Performance
RM-2280 A Correlation of the Critical Conditions for Homogeneous Bare Reactors
RM-3077-PR Some Remarks on Scientific Achievement in Communist China
P-87 Lift on Inclined Bodies of Revolution in Hypersonic Flow
P-198 Supersonic Flow around Cones at Large Yaw
P-214 The Compressible Boundary Layer
P-1214 A Study of Turbojet Engine Weight
P-1713 A Discussion of the Correlation of Critical Conditions for Bare Homogeneous Reactors

YOUNGS, J. W. T.

- RM-1300 Predictability of Demand for B-47 Airframe Spare Items
RM-1357 Confidence Intervals for Poisson Parameters in Logistics Research
RM-1413 The Prediction of Demand for Aircraft Spare Parts Using the Method of Conditional Probabilities
P-49 The Determination of Many-commodity Preference Scales by Two-commodity Comparisons
P-1451 Isobars and Antipodes
P-1785 Printed Circuits, Graphs, Manifolds
P-2081-2 The Imbedding of Graphs in Manifolds
P-2398 Minimal Imbeddings and the Genus of a Graph
P-2426 Simplest Imbeddings of the Complete 12 Graph
P-2428 Remarks on the Genus of a Complete Graph

★ Indicates publications which are out of print.

YURA, H. T.

P-2271 A New Approach to the Quantum Electrodynamics of a Medium

ZACHARIASEN, F.

RM-2092-AEC Relativistic Oscillator Strengths

P-1126 Scattering of Light by Protons

ZAGORIA, D. S.

P-2397 The Sino-Soviet Conflict over the Transition to Communism

P-2478-1 Khrushchev's Attack on Albania and Sino-Soviet Relations

P-2561 Some Comparisons between the Russian and Chinese "Models"

ZAHNER, V. D.

P-1046 The Influence of Structural Materials on the Weight, Capability, and Cost of a Weapon System

ZIEHE, T. W.

RM-2538 Studies in Machine Translation—10: Russian Sentence-structure Determination

P-1909 Glossary Lookup Made Easy

P-2197 The Nature of Data in Language Analysis

ZIRIN, H.

RM-1203-AEC Polynomial Approximations to Neutron-Deuteron Differential Angular Cross Sections

P-351 The Radiative Opacity of Stellar Matter

ZWICK, C. J.

P-1787 The Support of Future Weapons

